|  |  |
| --- | --- |
| **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**  2nd Meeting: Shanghai, CN, 13–19 Oct. 2012 | Document: JCT3V-B0025r1 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **CE5 Summary Report : Motion/mode Parameter Prediction** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Report | | |
| *Author(s) or Contact(s):* | Sehoon Yea  Yu-Lin Chang | Tel: Email:  Tel: Email: | +82-10-3968-0602 [sehoon.yea@lge.com](mailto:sehoon.yea@lge.com)  +886-3-5670766 ext. 25314 [yulin.chang@mediatek.com](mailto:yulin.chang@mediatek.com) |
| *Source:* | CE coordinators | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

A summary of proposals and cross-check results of CE5 is reported.

# Introduction

A summary of proposals and cross-check results of CE5 is reported.

## Mandates

### CE5.a

One proposal by Samsung (JCT2-A0040) is on simplification of the disparity coefficient and the improvement of the skip and direct motion vector prediction. Another CE5.a related proposal by Samsung (JCT2-A0041) is on using quarter resolution of the depth map for depth-based motion vector prediction to reduce the decoder complexity.

The mandates of this core experiment are as follows:

1. Evaluate the coding efficiency of the proposals (JCT2-A0040)
2. Verify the simplification and the complexity reduced by the proposals (JCT2-A0041)

### CE5.h

The mandates of this core experiment are as follows:

1. To further investigate ways to improve NBDV for generating disparity vector in terms of coding efficiency and complexity. *[JCT2-A0097,JCT2-A0126]*

- To further evaluate the NBDV scheme in terms of complexity & memory-access requirements

1. To further investigate ways to improve Merge/AMVP-lists construction in the context of the current CE. *[JCT2-A0014,JCT2-A0048,JCT2-A0096,JCT2-A0133,JCT2-A0134]*

## Participants

Participants with proposals at this meeting in CE5.a are as follows:

|  |  |  |
| --- | --- | --- |
| ***Participant*** | ***Contact*** | ***Email*** |
| LG | Jaewon Sung | [jw.sung@lge.com](mailto:jw.sung@lge.com) |
| INRIA | Thomas Guionnet | [Thomas.Guionnet@inria.fr](mailto:Thomas.Guionnet@inria.fr) |
| Sharp | Tadashi Uchiumi | [uchiumi.tadashi@sharp.co.jp](mailto:uchiumi.tadashi@sharp.co.jp) |
| Qualcomm | Li Zhang | [lizhang@qualcomm.com](mailto:lizhang@qualcomm.com) |
| Samsung | Jin Young Lee | [jinyoung79.lee@samsung.com](mailto:jinyoung79.lee@samsung.com) |
| MediaTek | Jian-Liang Lin  Jicheng An | [jl.lin@mediatek.com](mailto:jl.lin@mediatek.com),  [jicheng.an@mediatek.com](mailto:jicheng.an@mediatek.com) |

Participants with proposals at this meeting in CE5.h are as follows:

|  |  |  |
| --- | --- | --- |
| ***Participant*** | ***Contact*** | ***Email*** |
| LG | Jaewon Sung | [jw.sung@lge.com](mailto:jw.sung@lge.com) |
| INRIA | Thomas Guionnet | [Thomas.Guionnet@inria.fr](mailto:Thomas.Guionnet@inria.fr) |
| Sharp | Tadashi Uchiumi | [uchiumi.tadashi@sharp.co.jp](mailto:uchiumi.tadashi@sharp.co.jp) |
| Qualcomm | Li Zhang | [lizhang@qualcomm.com](mailto:lizhang@qualcomm.com) |
| Samsung | Jin Young Lee | [jinyoung79.lee@samsung.com](mailto:jinyoung79.lee@samsung.com) |
| MediaTek | Jian-Liang Lin  Jicheng An | [jl.lin@mediatek.com](mailto:jl.lin@mediatek.com),  [jicheng.an@mediatek.com](mailto:jicheng.an@mediatek.com) |
| Hisilicon | Yongbing Lin | [yblin@huawei.com](mailto:yblin@huawei.com) |
| Orange | E.G. Mora | [elie.mora@orange.com](mailto:elie.mora@orange.com) |

# List of input documents

## CE5.a

A total of 11 input contributions were gathered in this category, among which were 7 proposals. The input contributions can be roughly categorized as follows:

1. CE5.a experiments: Depth-to-Disparity conversion

JCT3V-B0081 (MediaTek), JCT3V- B0149 (Samsung)

1. Simplification of the disparity vector derivation and interview candidate derivation

JCT3V-B0073 (ETRI&KHU), JCT3V-B0082 (MediaTek)

1. Improvement on motion vector prediction

JCT3V-B0151 (Samsung), JCT3V-B0153 (Samsung)

1. Draft text

JCT3V-B0079 (MediaTek)

|  |  |  |  |
| --- | --- | --- | --- |
| **Participants** | **Doc No.** | **Title** | **Type** |
| ETRI | [JCT3V-B0073](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=278) | 3D-CE5.a related: Simplification on the disparity vector derivation | Proposal |
| MediaTek | [JCT3V-B0079](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=284) | 3D-CE5.a related: Draft text for the adopted simplified disparity vector derivation proposed in JCT3V-A0046 | Proposal |
| MediaTek | [JCT3V-B0081](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=286) | 3D-CE5.a results on unification of the depth to DV conversion | Proposal |
| MediaTek | [JCT3V-B0082](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=287) | 3D-CE5.a related: Simplification of the Inter-view candidate derivation | Proposal |
| NTT | [JCT3V-B0107](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=316) | CE5.a related: Cross check report of JCT3V-B0151 on median-based skip/direct motion vector prediction | Cross-Check |
| NTT | [JCT3V-B0108](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=317) | CE5.a related: Cross check report of JCT3V-B0153 on temporal motion vector prediction in dependent view | Cross-Check |
| Samsung | [JCT3V-B0149](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=259) | 3D-CE5.a results on inter-view motion vector derivation using max disparity in skip and direct modes | Proposal |
| Samsung | [JCT3V-B0151](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=260) | 3D-CE5.a related results on median-based skip and direct motion vector prediction | Proposal |
| Samsung | [JCT3V-B0153](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=261) | 3D-CE5.a related results on temporal motion vector prediction in dependent view | Proposal |
| Samsung | [JCT3V-B0171](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=369) | 3D-CE5.a cross check on simplification of the Inter-view candidate derivation of MediaTek (JCT3V-B0082) | Cross-Check |
| MediaTek | [JCT3V-B0193](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=401) | 3D-CE5.a cross-check on inter-view motion vector derivation using max disparity in skip and direct modes (JCT3V-B0149) | Cross-Check |
| MediaTek | [JCT3V-B0202](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=415) | 3D-CE5.a related: cross-check on simplification on the disparity vector derivation (JCT3V-B0073) | Cross-Check |
| ETRI&KHU | [JCT3V-B0206](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=420) | 3D-CE5.a: Cross check report of JCT3V-B0081 on unification of the depth to DV conversion of MediaTek | Cross-Check |

## CE5.h

A total of 50 input contributions were gathered in this category, among which were 23 proposals. The input contributions can be roughly categorized as follows:

1. Disparity vector derivation for interview motion-info candidate search in Merge/AMVP

B0088 (MediaTek), B0157(Samsung/LG), B0158(Samsung) – Neighbor block search order

B0096 (MediaTek), B0136(LG) - Parallelism

B0047(Qualcomm), B0135(LG) – Memory reduction

B0112(Sharp), B0113(Sharp), B0087(MediaTek) – Constrained DV

B0089(MediaTek), B0090(MediaTek)

1. Merge/AMVP list construction (redundancy check, candidate order change etc.)

B0048(Qualcomm), B0080(INRIA), B0089(MediaTek), B0095(Hisilicon)

B0086(MediaTek), B0050(Qualcomm), B0069(Orange), B0078(INRIA), B0111(Sharp)

1. Others

B0038(Sony) – MV compression

B0051(Qualcomm) – Residual prediction

|  |  |  |  |
| --- | --- | --- | --- |
| **Participants** | **Doc No.** | **Title** | **Type** |
| Sony | JCT3V-B0038 | 3D-CE5.h related: MV memory reduction on motion/mode parameter prediction | Proposal |
| Qualcomm | JCT3V-B0047 | 3D-CE5.h related: Improvements for disparity vector derivation | Proposal |
| Qualcomm | JCT3V-B0048 | 3D-CE5.h: Merge candidates derivation from disparity vector | Proposal |
| Qualcomm | JCT3V-B0050 | 3D-CE5.h related: Improved temporal motion vector prediction for merge | Proposal |
| Qualcomm | JCT3V-B0051 | 3D-CE5.h related: Advanced residual prediction for multiview coding | Proposal |
| Telecom ParisTech/Orange Labs | JCT3V-B0069 | 3D-CE5.h related: Modification of the Merge Candidate List for Dependant Views in 3DV-HTM | Proposal |
| INRIA | JCT3V-B0078 | 3D-CE5.h: Reducing the coding cost of merge index by dynamic merge index re-allocation | Proposal |
| INRIA | JCT3V-B0080 | 3D-CE5.h: Merge candidate list for disparity compensated prediction | Proposal |
| MediaTek | JCT3V-B0086 | CE5.h results on pruning process for the inter-view candidate | Proposal |
| MediaTek | JCT3V-B0087 | 3D-CE5.h related: Constrained DV for inter-view data access | Proposal |
| MediaTek | JCT3V-B0088 | 3D-CE5.h related: Unified temporal collocated picture for DV derivation | Proposal |
| MediaTek | JCT3V-B0089 | 3D-CE5.h related: Improvement on MV candidates for 3DVC | Proposal |
| MediaTek | JCT3V-B0090 | 3D-CE5.h related: Depth-oriented Neighboring Block Disparity Vector (DoNBDV) with virtual depth | Proposal |
| Hisilicon | JCT3V-B0095 | CE5.h related: Adaptive inter-view MVP candidate position for merging candidate list construction | Proposal |
| Hisilicon | JCT3V-B0096 | CE5.h related: removal of dependency between multiple PUs in a CU for disparity vector derivation | Proposal |
| Orange Labs | JCT3V-B0097 | 3D-CE5.h: Cross-check of reducing the coding cost of merge index by dynamic merge index re-allocation (JCT3V-B0078) | Cross-Check |
| Orange Labs | JCT3V-B0098 | 3D-CE5.h: Cross-check of merge candidate list for disparity compensated prediction (JCT3V-B0080) | Cross-Check |
| INRIA | JCT3V-B0099 | 3D-CE5.h related: Cross-check report of JCT3V-B0095 on Adaptive inter-view MVP candidate position for merging candidate list construction | Cross-Check |
| Hisilicon | JCT3V-B0100 | Cross-check report of LG's proposal JCT3V-B0133 | Cross-Check |
| Sharp | JCT3V-B0111 | 3D-CE5.h: Decoupling inter-view candidate for AMVP | Proposal |
| Sharp | JCT3V-B0112 | 3D-CE5.h related: Disparity vector restrictions | Proposal |
| Sharp | JCT3V-B0113 | 3D-CE5.h related: Restricted motion vector coding for inter-view prediction | Proposal |
| Sharp | JCT3V-B0114 | 3D-CE5.h: crosscheck of Merge candidates derivation from disparity vector (JCT3V-B0048) | Cross-Check |
| Sharp | JCT3V-B0115 | 3D-CE5.h related cross-check of results on disparity vector derivation from blocks coded by inter-view motion parameter prediction (JCT3V-B0157) | Cross-Check |
| Sharp | JCT3V-B0116 | 3D-CE5.h related: crosscheck of Removal of the parsing dependency of inter-view residual prediction (JCT3V-B0093) | Cross-Check |
| Sharp | JCT3V-B0117 | 3D-CE5.h related: cross-check of Unified temporal collocated picture for DV derivation (JCT3V-B0088) | Cross-Check |
| Sharp | JCT3V-B0118 | 3D-CE5.h related: cross-check of MV memory reduction on motion/mode parameter prediction (JCT3V-B0038) | Cross-Check |
| Sharp | JCT3V-B0120 | 3D-CE5.h related: cross-check of Support of parallel merge in disparity vector derivation (JCT3V-B0136) | Cross-Check |
| LG | JCT3V-B0133 | 3D-CE5.h Software fix of disparity derivation | Proposal |
| LG | JCT3V-B0135 | 3D-CE5.h Modified disparity vector derivation process for memory reduction | Proposal |
| LG | JCT3V-B0136 | 3D-CE5.h Related: Support of parallel merge in disparity vector derivation | Proposal |
| LG | JCT3V-B0137 | 3D-CE5.h related cross-check report for JCT3V-B0158 inter-view motion vector candidate construction in merge and AMVP modes by Samsung | Cross-Check |
| LG | JCT3V-B0138 | CE5.h related cross-check report for JCT3V-B0096 proposal on removal of dependency between multiple PUs in a CU for disparity vector derivation by Hisilicon | Cross-Check |
| Panasonic | JCT3V-B0144 | 3D-CE5.h related: Cross-check of Improved temporal motion vector prediction for merge (JCT3V-B0050) | Cross-Check |
| LG | JCT3V-B0148 | 3D-CE5.h related : Cross-check report for JCT3V-B0047 improvements for disparity vector derivation by Qualcomm | Cross-Check |
| Samsung/LG | JCT3V-B0157 | 3D-CE5.h related results on disparity vector derivation from blocks coded by inter-view motion parameter prediction | Proposal |
| Samsung | JCT3V-B0158 | 3D-CE5.h related results on inter-view motion vector candidate construction in merge and AMVP modes | Proposal |
| Samsung | JCT3V-B0172 | 3D-CE5.h cross check on support of parallel merge in disparity vector derivation of LG (JCT3V-B0136) | Cross-Check |
| Samsung | JCT3V-B0173 | 3D-CE5.h cross check on pruning process for the inter-view candidate of MediaTek (JCT3V-B0086) | Cross-Check |
| Samsung | JCT3V-B0174 | 3D-CE5.h cross check on disparity vector restrictions of Sharp (JCT3V-B0112) | Cross-Check |
| NTT | JCT3V-B0190 | CE5.h: Crosscheck report of JCT3V-B0086 on the pruning process for the inter-view candidate | Cross-Check |
| MediaTek | JCT3V-B0191 | 3D-CE5.h cross-check on modified disparity vector derivation process for memory reduction (JCT3V-B0135) | Cross-Check |
| MediaTek | JCT3V-B0192 | 3D-CE5.h Related cross-check on parallel merge in disparity vector derivation (JCT3V-B0136) | Cross-Check |
| Sony | JCT3V-B0195 | 3D-CE5.h related: Cross-check of constrained DV for inter-view data access (JCT3V-B0087) | Cross-Check |
| Sony | JCT3V-B0195 | 3D-CE5.h related: Cross-check of restricted motion vector coding for inter-view prediction (JCT3V-B0113) | Cross-Check |
| MediaTek | JCT3V-B0199 | 3D-CE5.h cross-check on decoupling inter-view candidate for AMVP (JCT3V-B0111) | Cross-Check |
| MediaTek | JCT3V-B0203 | 3D-CE5.h related: Cross-check of Modification of the Merge Candidate List for Dependant Views in 3DV-HTM (JCT3V-B0069) | Cross-Check |
| MediaTek | JCT3V-B0204 | 3D-CE5.h: crosscheck of pruning process for the inter-view candidate (JCT3V-B0086) | Cross-Check |
| Orange Labs | JCT3V-B0208 | 3D-CE5.h related: Cross check of JCT3V-B0136 on support of parallel merge in disparity vector derivation | Cross-Check |
| Qualcomm | JCT3V-B0210 | 3D-CE5.h related: Cross check of JCTVC-B0089 on improvement on MV candidates for 3DVC | Cross-Check |

# Summary of proposals & results

## CE5.a experiments

A disparity vector, which is derived from the neighboring blocks or the corresponding depth block of the current blocks, is employed to bring motion information for skip and direct motion vector from the inter-view reference frame (JCT2-A0045). If the neighboring blocks do not have an inter-view motion vector, a disparity vector in the corresponding depth block is derived and used. Two different disparity derivation methods were tested in CE5.a. The first one is max disparity derivation with full search. The second one is max disparity derivation with partial search. Both of these disparity derivation methods were proposed in the last meeting (JCT3V 1st meeting). The two methods were proposed in JCT3V-A0040 and JCT3V-A0046. All the tests are conducted with 3D-ATM 5.1r2.

**Test 1: Max disparity derivation with full search from JCT3V-A0040**

**Contribution: JCT3V-B0149 (Samsung)** (**Cross-Checked by JCT3V-B0193**)

A max disparity can be derived from a max depth value among all the depth samples (full search). The full search disparity vector derivation in Skip/Direct mode is tested in Test 1.

Table 1 Test 1 results



**Test 2: Max disparity derivation with partial search from JCT3V-A0046 in skip/direct mode**

**Contributions: JCT3V-B0081 (MediaTek), JCT3V-B0149(Samsung) (Cross-Checked by JCT3V-B0193, JCT3V-B0206**)

The simplified disparity vector derivation in Skip/Direct mode proposed by MediaTek in JCT3V-A0046 to unify the depth to DV conversions in Skip/Direct mode and Inter mode is tested in Test 2. With this unification, the maximum depth value of four corner depth samples within the associated depth block is used to derive the DV for both Skip/Direct and Inter modes.

Table 2 Test 2 results



Table 3 Encoder/decoder time analysis for test 1



Table 4 Encoder/decoder time analysis for test 2



The computational complexity analysis of test 1 and test 2 are shown in Table 3 and Table 4. Theoretically, the derivation scheme of test 2 requires less memory access comparing to the scheme of test 1. From the results, test 1 and test 2 both achieves -0.21% BD-rate gain for texture coding, -0.18% BD-rate gain for coded view, and -0.18% BD-rate gain for synthesized view. There’s only very little difference on the coding gain by these two methods.

It is suggested to adopt the DV derivation scheme in skip/direct mode from JCT3V-A0046 (JCT3V-B0081, JCT3V-B0149 ).

## CE5.a related

* **JCT3V-B0073 [ETRI&KHU] 3D-CE5.a related: Simplification on the disparity vector derivation (Cross-Checked by JCT3V-B0202)**

This contribution proposes a simplified disparity vector derivation method for saving the memory access bandwidth. The implementation of the proposed process can be achieved with sharing a depth sample to derivate the disparity vector in all sub-blocks inside each MB. It is indicated that the proposed approach reduces searching and comparison operations to find maximum depth samples in every sub-blocks and additionally reduces of the encoder complexity. It is reported that the proposed algorithm increased slightly 0.07% BD rate for texture views and increased slightly 0.04% BD rate for synthesized views with 98% encoding time, and 100% decoding time.

* **JCT3V-B0079 [MediaTek] 3D-CE5.a related: Draft text for the adopted simplified disparity vector derivation proposed in JCT3V-A0046**

In the first JCT-3V meeting, a simplification proposed in JCT3V-A0046 was adopted into 3D-ATM to reduce the number of the depth samples to be accessed for the derivation of the disparity vector (DV). By deriving the DV from a maximum depth value of four corner depth samples instead of all depth samples within the associated depth block, 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. In this contribution, the text is provided for this simplification. This simplification is also tested again on current 3D-ATM, ATM-5.1r2. The results reportedly show that this proposed simplification does not cause any coding loss in ATM-5.1r2.

* **JCT3V-B0082 [MediaTek] 3D-CE5.a related: Simplification of the Inter-view candidate derivation (Cross-Checked by JCT3V-B0171)**

In the AVC-based 3D video coding, ATM-5.1r2, the inter-view candidate in Skip/Direct mode is derived from the motion vectors (MVs) of two different corresponding blocks in the reference view. To derive the inter-view candidate, the MV of list 0 is inferred from a corresponding block located by a disparity vector derived for list 0, and the MV of list 1 is inferred from another corresponding block located by a different disparity vector derived for list 1. In this contribution, we propose to derive the inter-view candidate from a single corresponding block located by a disparity vector derived for list 0 and list 1 to reduce the memory access bandwidth for the inter-view motion data fetch. The experimental results reportedly show that this proposed simplification brings no coding loss compared to ATM-5.1r2.

* **JCT3V-B0151 [Samsung] 3D-CE5.a related results on median-based skip and direct motion vector prediction (Cross-Checked by JCT3V-B0107)**

In the proposed approach, the median-filtered disparity vector is derived to bring the inter-view motion vector for the skip and direct modes. If the disparity vector in the neighboring block A, B, or C is unavailable, a max disparity which is associated with Cb is used for the unavailable block. The max disparity can be derived from a max depth value among four corner depth samples (JCT2-A0040 and JCT2-A0046). Then, the motion vector of the corresponding block in the reference view, which is pointed by the max disparity, is employed as the skip and direct motion vector. It is shown that the proposed method achieves the coding gain of -0.37% in the texture coding. In some sequence, the BD rate reduction can be up to 0.99%.

* **JCT3V-B0153 [Samsung] 3D-CE5.a related results on temporal motion vector prediction in dependent view (Cross-Checked by JCT3V-B0108)**

In the proposed design, a concept of an inter-view motion vector is applied to the temporal motion vector prediction. In the temporal prediction, when the temporal motion vector is unavailable in the neighboring block A, B, or C, the proposed method employs the inter-view motion vector for the unavailable blocks instead of the zero vector. A max disparity which is associated with Cb is used for the inter-view motion vector derivation. The max disparity can be calculated from a max depth value among four corner depth samples (JCT2-A0040 and JCT2-A0046). It is shown that the proposed method achieves the coding gain of -0.11% in only texture and overall coding. In some sequence, the BD rate reduction can be up to 0.19%.

## CE5.h results

* **JCT3V-B0048 [Qualcomm] 3D-CE5.h: Merge candidates derivation from disparity vector (Cross-Checked by JCT3V-B0114)**

When inter-view motion prediction is enabled, the current HTM design of the merge candidate list includes an inter-view predicted motion candidate from a corresponding block in a reference view if available. However, such a candidate might be identical to existing spatial merging candidates in the merge candidate list. In addition, the disparity vector is converted to a disparity motion vector only when the inter-view predicted motion candidate located by the disparity vector is unavailable. Therefore, as a follow-up proposal of JCT3V-A0096, it is proposed to 1) remove duplicated candidates with limited additional number of pruning operations; 2) add disparity motion vector candidate before spatial merging candidates regardless the availability of inter-view predicted motion candidate; 3) add up to two more candidates derived with two horizontally shifted disparity motion vectors. Compared to the current HTM design, the proposed method achieves compression efficiency gain of 0.5% for coded views in terms of BD rate.

* **JCT3V-B0078 [INRIA] 3D-CE5.h: Reducing the coding cost of merge index by dynamic merge index re-allocation (Cross-Checked by JCT3V-B0097)**

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. It is reported in this document that the inter-view motion vector predictor is not always the most probable candidate. It actually depends on the video sequence characteristics. Therefore, a dynamic candidate vector list ordering is proposed. Coding gains of 0.4 % on average are observed on side views and up to 1.0% is attained for the Ghost Town Fly sequence for both side views.

* **JCT3V-B0080 [INRIA] 3D-CE5.h: Merge candidate list for disparity compensated prediction (Cross-Checked by JCT3V-B0098)**

HEVC implements a candidate vector list for merge and skip modes. The construction of this list has been extensively studied in the JCT-VC group (see for instance JCTVC-G039). It has been shown in JCTVC-I0293 that it is possible to improve the HEVC coding performance by adding in the merge list copies of the first candidate shifted by an arbitrary offset. The same basis is considered in this document and applied to disparity compensation. A gain of 0.3 % is obtained on average on side views.

* **JCT3V-B0086 [MediaTek] CE5.h results on pruning process for the inter-view candidate (Cross-Checked by JCT3V-B0173)**

This contribution presents results of CE5.h experiments related to the improvement of the pruning process proposed by MediaTek in JCT3V-A0048. Seven experiments are conducted for the removal of redundant candidates in the reconstruction of the AMVP candidate list, merging candidate list, and the combinations. Among seven experiments, Test6 provides the best performance in terms of complexity reduction and coding gain. The experiments results of Test6 reportedly show 0.3% and 0.2% BD-rate saving for view 1 and view 2, respectively, and 0.1% BD-rate saving for the coded and synthesized views, while also reducing the required comparisons in the pruning processes of the inter, merge and skip modes.

* **JCT3V-B0111 [Sharp] 3D-CE5.h: Decoupling inter-view candidate for AMVP (Cross-Checked by JCT3V-B0199)**

At the last meeting, a simplified motion vector candidate derivation for AMVP (JCT3V-A0014) has been proposed. The method removes the dependency between the 3D extension part (inter-view candidate) and HEVC part (regular spatial and temporal candidates) to minimize the extension part. It removes the case that the inter-view candidate is not available and removes the pruning process between the inter-view and regular ones. This decoupling is also beneficial for decoder complexity reduction because it can avoid the unnecessary candidate derivation process. It is reported that average BD-rate of the proposal is not changed from that of the anchor (HTM4.0.1).

* **JCT3V-B0133 [LG] 3D-CE5.h Software fix of disparity derivation (Cross-Checked by JCT3V-B0100)**

In HTM 4.0.1, a flag is used to indicate whether a block is DV-MCP block or not. The flag is saved with other motion parameters such as motion vector and reference index. In HTM4.0.1 there is a bug which through the flag can be copied to neighbour blocks, which is not desirable. This contribution presents the effect of the bug and reports the simulation results after bug fixing. As the bug does not affect to the coding performance, experiment results show exactly same results with those of HTM4.0.1 anchor coding case.

* **JCT3V-B0135 [LG] 3D-CE5.h Modified disparity vector derivation process for memory reduction (Cross-Checked by JCT3V-B0191)**

Current disparity derivation algorithm in HTM4.0.1 uses neighbour DCP and DV-MCP blocks to find derive a disparity vector. To use the DV-MCP block in the disparity derivation process, additional data should be kept in the memory. This contribution presents a modified disparity derivation algorithm where the above blocks are used only if they belong to the same LCU that current PU belongs to. This modification makes the DV-MCP information of the blocks in upper LCU does not have to be kept in memory. Experiment results reportedly shows that the modification bring 0.0%, 0.2% BD bitrate losses for V1 and V2, respectively. For coded only, synthesized only, and coded & synthesized, 0.0%, 0.0%, 0.0% BD bitrate losses, respectively.

## CE5.h related

* **JCT3V-B0038 [Sony] 3D-CE5.h related: MV memory reduction on motion/mode parameter prediction (Cross-Checked by JCT3V-B0118)**

This contribution proposes MV memory reduction on MPP. It is suggested that the numbers of MV are compressed right after decoding a picture of each view. Two approaches with different compression ratios of MVs are proposed. The first approach can achieve higher compression ratio of MVs than the second one, yet there is more coding loss. It is reported that experimental results show 0.6% BD-rate increase in the first approach and 0.1% BD-rate increase in the second approach. We recommend adopting one of them to the current HTM.

* **JCT3V-B0047 [Qualcomm] 3D-CE5.h related: Improvements for disparity vector derivation (Cross-Checked by JCT3V-B0148)**

This contribution presents modifications for disparity vector derivation in the current 3D-HEVC. In the current 3D-HEVC design, a disparity vector is estimated with searching disparity motion vectors (DMV) of coded blocks in spatial and temporal neighbors as well as derived disparity vectors (DDV) which may be stored to each block. However, using DDV requires large memory bandwidth not only for accessing the reference pictures but also for storing information related to the DDV since the DDV needs to be present for each block in all the pictures of the decoded picture buffer (DPB). Thus, in this contribution, it is proposed that DDV is stored only in the current view component to reduce the memory size, and not in a reference picture. On top of that, the contribution proposes a temporal picture selection method that allows up to two candidates (i.e., the same number with the current design). In summary, the proposal reduces the memory size as much as for storing the DDV in the DPB, and achieves a coding gain about 0.1% bit-rate saving for texture views.

* **JCT3V-B0050 [Qualcomm] 3D-CE5.h related: Improved temporal motion vector prediction for merge (Cross-Check by JCT3V-B0144)**

In current 3D-HEVC, a target reference index for temporal merging candidate is set according to the neighboring prediction unit. When the target reference index corresponds to a reference picture in the same view while the motion vector of the co-located prediction unit (PU) points to an inter-view reference picture and vice versa, temporal motion vector prediction (TMVP) candidate is considered as unavailable. To address this issue, it is proposed that one additional target reference index is used, so that TMVP candidate can be supported for the above cases. For 3D-HEVC, the proposed method provides about 0.3% average bitrate saving for the all the coded views and 0.7% bitrate saving for the non-base views.

* **JCT3V-B0051 [Qualcomm] 3D-CE5.h related: Advanced residual prediction for multiview coding (Cross-Check N/A)**

Inter-view residual prediction is enabled in the current HTM design to code the residue of dependent texture views more efficiently. In this proposal, an advanced residual prediction (ARP) is proposed to further improve the coding efficiency of inter-view residual prediction. In ARP, to ensure high correlation between residues of two views, motion of the current block of picture in current view is applied to the corresponding block in a reference view picture to generate residual in the base view to be used for inter-view residual prediction. Moreover, an adaptive weighting factor is applied to the residue signal so that the prediction error is further reduced. Compared to the current HTM design, the proposed method achieves compression efficiency gain of 0.9% for coded views in terms of BD rate.

* **JCT3V-B0069 [Telecom ParisTech/Orange Labs] 3D-CE5.h related: Modification of the Merge Candidate List for Dependant Views in 3DV-HTM (Cross-Checked by JCT3V-B0203)**

This document presents a modification to the Merge candidate list for a given PU in a dependant view in 3DV-HTM. While there is already a multi-view candidate in this list, it is always preferred to be temporal (referencing a frame in the same view but at a different time instant, hence it is a motion vector) over interview (referencing a frame in another view at the same time instant, hence it is a disparity vector). In this proposal, an interview candidate is considered in the Merge candidate list, along side the multi-view temporal one. The new candidate can either be added in the secondary candidate list, or replace the temporal in the primary list (in this case the temporal would be moved to the secondary list). The first method achieves -0.5%, -0.6%, -0.2% and -0.2% gain on average for video 1, video 2, synthesized views, and coded+synthesized respectively while reducing encoding time to 97% (decoding time remains unchanged). The second method achieves -0.6%, -0.6%, -0.2% and -0.2% gains on average for video 1, video 2, synthesized views, and coded+synthesized respectively while reducing encoding time to 96% and decoding time to 99%.

* **JCT3V-B0087 [MediaTek] 3D-CE5.h related: Constrained DV for inter-view data access (Cross-Checked by JCT3V-B0195)**

In the HEVC-based 3D video coding, HTM 4.0.1, a derived disparity vector (DV) is used to locate the corresponding block in the neighboring view picture for the inter-view motion prediction and inter-view residual prediction. Considering that the input data is rectified to avoid misalignment of camera geometry, the vertical component of the DV used for inter-view residual prediction is restricted to zero. However, the vertical component of the DV used for inter-view motion parameter prediction is not restricted to zero. In this contribution, we proposed to restrict the vertical component of the derived DV for inter-view data access to zero for unification and simplification. The experimental results reportedly show that the proposed scheme brings no BD-rate changes for overall results.

* **JCT3V-B0088 [MediaTek] 3D-CE5.h related: Unified temporal collocated picture for DV derivation (Cross-Checked by JCT3V-B0117)**

In the HEVC-based 3D video coding, HTM 4.0.1, a mechanism that allows the collocated picture to be changed at prediction unit (PU) level is utilized to search temporal neighboring blocks to derive the disparity vector. This contribution proposes a constraint to unify the temporal collocated picture for all PUs within the same picture to ease the memory access burden caused by the PU-level adaptive collocated picture selection. In this contribution, two schemes are proposed to provide different signaling methods of the temporal collocated picture for disparity vector (DV) derivation. In scheme 1, an additional syntax is used to signal the temporal collocated picture for DV derivation in the same manner as the signaling of temporal collocated picture for temporal motion vector predictor (TMVP). In scheme 2, the signaling of the temporal collocated picture for DV derivation and the one for TMVP uses the same syntax. Besides, in scheme 2, one additional temporal neighboring block is checked to increase the probability of having an available DV. Experimental results show that both schemes have no overall coding performance changes compared to HTM-4.0.1 while the burden of memory access is reduced.

* **JCT3V-B0089 [MediaTek] 3D-CE5.h related: Improvement on MV candidates for 3DVC (Cross-Checked by JCT3V-B0210)**

In the current HTM, the inter-view candidate is introduced into the MV candidate list for AMVP and merge blocks. To get the inter-view candidate, an estimated DV is obtained first. If no estimated DV can be found, a default zero-DV is used. Then an inter-view motion predictor or a disparity vector predictor is given as the inter-view candidate, based on the estimated DV and the current reference picture. In this contribution, we propose three simple modifications to further improve MV candidates in 3DVC. First, the default zero-DV is forbidden in the DV estimation process. The inter-view candidate will not be used if the estimated DV is unavailable. Second, AMVP candidate filling process will be simplified by eliminating redundancy neighboring checking for DVs, Finally merge candidate list will be more reasonable by moving back the inter-view candidate if it turns out to be a disparity vector predictor instead of an inter-view motion predictor. Experimental results show that, the proposed solution achieves about 0.5% BD-rate gain on video 1/video 2 and 0.2% BD-rate gain on the coded & synthesized view respectively, without increasing the computational complexity.

* **JCT3V-B0090 [MediaTek] 3D-CE5.h related: Depth-oriented Neighboring Block Disparity Vector (DoNBDV) with virtual depth (Cross-Check N/A)**

In HTM 4.0.1, the neighboring block disparity vector (NBDV) mode is used to replace the original predicted depth map (PDM) for inter-view motion prediction. In this contribution, a new estimated disparity vector – depth oriented neighboring block disparity vector (DoNBDV) is proposed to enhance the accuracy of the NBDV by utilizing the coded depth map. By referring to the NBDV and the coded depth information, the inter-view information can be predicted more accurately without maintaining a whole frame buffer like the predicted depth map. The experimental results reportedly show that 1.0% and 1.2% BD-Rate gains are achieved for video 1 and video 2, 0.3% BD-Rate gains is achieved for coded and synthesized views while applying the DoNBDV in the AMVP mode and the merge mode.

* **JCT3V-B0095 [Hisilicon] CE5.h related: Adaptive inter-view MVP candidate position for merging candidate list construction (Cross-Checked by JCT3V-B0099)**

This contribution proposes to construct MERGE candidate list by adaptively inserting an inter-view MVP candidate. In 3D-HTM, an inter-view MVP candidate for dependent view is obtained based on its reference view. It is observed that the derived inter-view MVP may be either temporal motion vector (MV) or inter-view disparity vector (DV). It is proposed that the inter-view MVP candidate’s position in the MERGE candidate list is not fixed, *i.e.*, the first position is taken when the inter-view MVP is a kind of MV while a different position close to the end of the list is assigned when the inter-view MVP is a kind of DV. It is reportedly shown that the proposed method archives average -0.23%, -0.21% BD-rate reduction for texture view1 and view2, respectively, with comparison to HTM4.0.1.

* **JCT3V-B0096 [Hisilicon] CE5.h related: removal of dependency between multiple PUs in a CU for disparity vector derivation (Cross-Checked by JCT3V-B0138)**

This contribution proposes to remove the dependency among multiple PUs in a CU for purpose of enabling PU-based parallel disparity derivation. In 3D-HTM implementation, it is not possible for two PUs within a CU, e.g. with Nx2N partition, to perform disparity vector derivation process in a parallel way. This is because one or more of the neighbour blocks involved in disparity vector derivation for 2nd PU is located in the 1st PU. The dependency between the two PUs disables parallelism of PU-based disparity vector derivation. Such dependency is removed in this contribution. It is reportedly shown the coding efficiency is -0.1% and 0.0% BD-rate saving for texture view1 and view2, respectively, with comparison to HTM4.0.1.

* **JCT3V-B0112 [Sharp] 3D-CE5.h related: Disparity vector restrictions (Cross-Checked by JCT3V-B0174)**

This contribution presents disparity vector restrictions for HTM4.0.1. In practical usage, base view and other views need to be decoded simultaneously. In the current scheme, the other view depends on the data of base view and the reference area of base view (the range of disparity vector) is not restricted. In this contribution, the restriction of disparity vectors range is proposed. The proposal consists of two parts. The first one clips the disparity vector to restrict the reference image area. The second one clips to the internal disparity vector to restrict the area of base layer’s motion information, at inter-view vector candidate derivation process. It is reported both restrictions doesn’t affect RD-performance.

* **JCT3V-B0113 [Sharp] 3D-CE5.h related: Restricted motion vector coding for inter-view prediction (Cross-Checked by JCT3V-B0197)**

This contribution presents a motion vector coding tool for inter-view prediction for HEVC-3V, which is related to CE 5. The proposal introduces a restriction on inter-view vectors and discards the vertical motion vector difference (mvd) if the restriction is applied, considering sequences which are produced with 1-D camera arrangement and the vertical disparity is always zero. The simulation result reports this restriction decrease encoding complexity and there are coding gains about 0.4 % compared to encoder only restriction in sequences generated with CG.

* **JCT3V-B0136 [LG] 3D-CE5.h Related: Support of parallel merge in disparity vector derivation (Cross-Checked by JCT3V-B0208)**

In HTM anchors so far, parallel merge scheme has not been activated. Thus, the A0126 proposal adopted in the last meeting did not present experimental results with the scheme. To reduce complexity for deriving availabilities of neighbor blocks and dispatching motion information of them and to maintain parallelism enabled by the scheme, we should also consider parallel merge in disparity vector derivation process. This proposal shows experimental results for parallel merge to be added to the A0126 proposal, and the benefits of inter-view motion prediction are still preserved even with the parallel merge.

* **JCT3V-B0157 [Samsung/LG] 3D-CE5.h related results on disparity vector derivation from blocks coded by inter-view motion parameter prediction (Cross-Checked by JCT3V-B0115)**

For disparity vector derivation, a neighboring blocks based method was integrated on the current 3DV-HTM (M24937 and JCT2-A0126). This proposal presents the more improved disparity vector derivation method. The proposed method achieves the bit reduction of -0.2% and -0.3% in dependent texture views as compared with an anchor. In some sequences, the coding gain of -0.7% is obtained.

* **JCT3V-B0158 [Samsung] 3D-CE5.h related results on inter-view motion vector candidate construction in merge and AMVP modes (Cross-Checked by JCT3V-B0137)**

For inter-view motion vector candidate construction in merge and AMVP modes, a neighboring blocks based approach was integrated on the current 3DV-HTM (M24937 and JCT2-A0126). In this proposal, the more improved inter-view motion vector candidate construction method is introduced. The proposed method achieves the bit reduction of -0.2% and -0.3% in dependent texture views as compared with an anchor. In some sequence, the coding gain of -0.9% is obtained.

# Closing Remarks

It is recommended the CE be continued and investigate proposed designs in further details.