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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: JCT3V-A0171 |

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| *Title:* | **JCT-3V BoG Report : Motion/mode Parameter Prediction** | | |
| *Status:* | Input Document | | |
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| *Source:* | BoG | | |

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# Abstract

A BoG meeting on CE5.h was held Tuesday, July 18, 2012 from 19:00 through 21:00. Approximately 15 delegates were present. A summary of discussions and recommendations from the BoG is provided in this document.

# Mandates of the BoG

The mandates of the BoG are

1. Discuss open issues and find out possible items/ways for harmonization
2. Make recommendations to JCT-3V on disposal of input documents & continuation of the CE

# Summary of the CE

## Decisions on CE5.h at the 100th MPEG (Geneva) meeting

In Geneva meeting, it was decided that :

1. Two options within the HTM reference SW for disparity vector generation will be made available :
2. PDM-based approach - a.k.a. DMDV (Depth Map Disparity Vector)

: the anchor method in the current 3DV-HTM SW (m22571)

B. Inter-view motion vector-based approach - a.k.a. NBDV (Neighboring Blocks Disparity

Vector)

: the result of harmonization of m25024, m24989, m24937 based upon Qualcomm’s SW implementation of m24937 also available in the current 3DV-HTM SW

1. Changes in the CTC as well as the reference SW will be made to remove the dependency between the two dependent views, which is desirable from the bitstream extraction and coding efficiency viewpoints.

Based upon the abovementioned decisions, the mandates of the CE included :

1. To investigate potential benefits of combining the idea of GDV (Global Disparity Vector) with the inter-view motion vector-based approach. In this investigation, NBDV will be used as anchor.

=> No input for this mandate at this meeting

2.To compare pros and cons of the two approaches (i.e., DMDV & NBDV) for generating disparity vector in terms of coding efficiency and complexity

=> 2 inputs for this mandate at this meeting

## Categorization of the input contributions

The input contributions in CE5.h at this meeting can be categorized as follows:

* + DMDV (Depth Map Disparity Vector)

: A0013, A0031, A0047

* + NBDV (Neighboring Blocks Disparity Vector)

: A0097, A0126

* + Modification of Merge/AMVP-list construction

: A0014, A0048, A0049, A0096, A0133, A0134

# Summary of the BoG Discussion

## Modification of Merge/AMVP-list construction

- A0049 (MediaTek) : achieves highest significant coding improvement among all the relevant proposals, simplification of the derivation of interview merge candidate while achieving 0.4% for the coded & synthesized cases.

- Other proposals regarding on Merge/AMVP are to be further studied in the CE.

- One opinion suggesting to separate the candidate-list construction for Merge and AMVP and continue the CE

- The BoG recommends to adopt the motion skip/merge candidate derivation in A0049.

## DMDV (Depth Map Disparity Vector) approach

- It was pointed out and agreed that the approaches in A0013 and A0047 are identical.

- No action recommended for the proposals in this category

## NBDV (Neighboring Blocks Disparity Vector) approach

- There seemed to be a general agreement among participants of the BoG that NBDV could provide substantial complexity reduction without coding loss.

- The BoG recommends adoption of NBDV into the TMuC and the potential WD. The proponents will provide the corresponding text for the WD.

## Which method to use in CTC? (i.e., DMDV vs. NBDV)

**-** There was a suggestion to use NBDV in CTC and to apply a bug-fix (A0049) in spirit to the SW. Several participants agreed to the suggestion. It was also mentioned that the dependency among views also needs to be removed (as per the 2nd decision from the 100th meeting).

- There was an agreement on the above suggestion. Therefore, the BoG recommends to use NBDV (A0097) in CTC.

- It was agreed that DMDV will still remain available in the SW for possible future investigations. Simulations based on DMDV should disable prediction between two dependent views, as e.g., proposed in A0049 and A0095.

- A0126 proposes to further simplify the NBDV. The reported coding loss is negligible.

: Multiple participants showed support on this proposal.

: The proposed method only checks one temporal frame. Within this frame, only two 4x4 blocks are checked.

: A question on the line buffer increase was raised. One additional bit storage and one additional disparity vector for each (inter) PU.

- The BoG recommends to adopt this proposal into the 3DV HTM SW.

# Suggested CE mandates

1. To further investigate ways to improve NBDV for generating disparity vector in terms of coding efficiency and complexity

- To investigate potential benefits of combining the idea of GDV (Global Disparity Vector)

- To further evaluate the pros and cons of the method in A0126 (to be adopted in the SW) vs. the anchor approach in NBDV

1. To further investigate ways to improve Merge/AMVP-lists construction in the context of the current CE.

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# Appendix-I: List of participants & input documents

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

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| ***Participant*** | ***Contact*** | ***Email*** |
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A list of input documents follows.

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| **Participants** | **Doc No.** | **Title** | **Type** |
| Sharp | [JCT2-A0013](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=19) | 3D-CE5.h related: Simplification of depth-based inter-view prediction | Proposal |
| Sharp | [JCT2-A0014](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=20) | 3D-CE5.h related: Simplification of AMVP | Proposal |
| Samsung | [JCT2-A0031](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=23) | 3D-CE5.h related results on improved residual prediction | Proposal |
| MediaTek | [JCT2-A0047](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=39) | 3D-CE5.h related: Simplification on disparity vector derivation for HEVC-based 3D video coding | Proposal |
| MediaTek | [JCT2-A0048](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=40) | 3D-CE5.h related: Pruning process for inter-view candidate | Proposal |
| MediaTek | [JCT2-A0049](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=41) | 3D-CE5.h related: Inter-view motion prediction for HEVC-based 3D video coding | Proposal |
| Samsung | [JCT2-A0079](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=71) | 3D-CE5.h: Cross check on pruning process for inter-view candidate of MediaTek (JCT2-A0048) | Cross-Check |
| Samsung | [JCT2-A0080](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=72) | 3D-CE5.h: Cross check on simplification of depth-based inter-view prediction of Sharp | Cross-Check |
| Qualcomm | [JCT2-A0095](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=87) | 3D-CE5.h related: Bug fix for independent estimated depth maps of non-base views in CTC | Bug-Fix |
| Qualcomm | [JCT2-A0096](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=88) | 3D-CE5.h related: Improved merge mode for inter-view predicted motion | Proposal |
| Qualcomm | [JCT2-A0097](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=89) | 3D-CE5.h: Disparity vector generation results | Proposal |
| LG | [JCT2-A0126](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=142) | 3D-CE5.h: Simplification of disparity vector derivation for HEVC-based 3D video coding | Proposal |
| INRIA | [JCT2-A0131](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=147) | CE5.h related: Information on the impact of the merge candidate list pruning process on side views encoding | Information |
| HHI | [JCT2-A0132](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=148) | 3D-CE5.h related: Cross check of independent estimated depth maps of Qualcomm | Cross-Check |
| INRIA | [JCT2-A0133](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=149) | CE5.h related: Reducing the coding cost of merge index by dynamic merge candidate list re-ordering | Proposal |
| INRIA | [JCT2-A0134](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=150) | CE5.h related: Merge candidate list extension for disparity compensated prediction | Proposal |
| Qualcomm | [JCT2-A0137](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=153) | 3D-CE5.h related: Cross check of JCT2-A0126 of LG | Cross-Check |
| Qualcomm | [JCT2-A0139](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=155) | 3D-CE5.h related: Cross check of Inter-view motion prediction of MediaTek | Cross-Check |
| NTT | [JCT2-A0141](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=157) | 3D-CE5.h related: Cross-check report of JCT2-A0031 on improved residual prediction | Cross-Check |
| Sony | [JCT2-A0142](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=158) | 3D-CE5.h related: Cross-check report of JCT2-A0095 on bug fix for estimated depth maps | Cross-Check |
| Sony | [JCT2-A0143](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=159) | 3D-CE5.h related: Cross-check report of JCT2-A0014 on simplification of AMVP | Cross-Check |
| LG | [JCT2-A0156](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=173) | 3D-CE5.h: Cross check report on Disparity vector generation results of Qualcomm | Cross-Check |
| LG | [JCT2-A0157](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=174) | 3D-CE5.h related: Cross check report on Improved merge mode for inter-view predicted motion of Qualcomm | Cross-Check |
| Orange | [JCT2-A0160](http://phenix.it-sudparis.eu/jct2/doc_end_user/current_document.php?id=170) | 3D-CE5.h related: Cross Check of Disparity Vector Derivation Simplification by MediaTek (JCT2-A0047) | Cross-Check |

# Appendix-II: Summary of proposals & results

* **JCT2-A0134 [INRIA] CE5.h related: Merge candidate list extension for disparity compensated prediction**

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 0.4 % is obtained on average on side views.

* **JCT2-A0133 [INRIA] CE5.h related: Reducing the coding cost of merge index by dynamic merge candidate list re-ordering**

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 0.15 % on average are observed on side views and up to 1.1% is attained for the GTFly sequence view 2.

* **JCT2-A0097 [Qualcomm] CE5.h: Disparity vector generation results**

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 in the latest HTM software this proposal. It is reported that deriving the disparity vector from neighbouring blocks will reduce the complexity greatly and the cost in terms of compression efficiency is negligible.

* **JCT2-A0096 [Qualcomm] 3D-CE5.h related: Improved merge mode for inter-view predicted motion**

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 addition 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 view, respectively, in terms of BD rate.

* **JCT2-A0013 [Sharp] 3D-CE5.h related: Simplification of depth-based inter-view prediction**

This contribution presents a coding tool of depth-based inter-view prediction (CE5 related) for HTM and its simulation result. This proposed technique is for PDM-based approach with disparity vector generation. The proposal decreases number of samples needed for deciding disparity vector from a PDM block. The simulation result reports there is no coding loss in average comparing to the anchor HTM3.1.

* **JCT2-A0047 [MediaTek]** **3D-CE5.h related: Simplification on disparity vector derivation for HEVC-based 3D video coding**

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. In HTM-3.1, 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).

* **JCT2-A0048 [MediaTek]** **3D-CE5.h related: Pruning process for inter-view candidate**

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.

* **JCT2-A0049 [MediaTek]** **3D-CE5.h related: Inter-view motion prediction for HEVC-based 3D video coding**

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, we propose 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.