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| *Title:* | **3D-CE5.h: Merge candidates derivation from disparity vector** | | |
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# Abstract

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.

# Introduction

In 3D-HEVC, up to six merging candidates are made available for selection when inter-view motion prediction is enabled. During the merge candidate list construction process, four main steps are required in current 3D-HTM when inter-view motion prediction is enabled:

* One candidate derived from inter-view motion prediction, is added to the merge candidate list if available.

As depicted in Figure 1, a corresponding block in the reference view is located based on the disparity vector [2]. The Inter-view Predicted Motion Candidate (IPMC), derived from the corresponding block, if available, is added. Otherwise, the disparity vector is converted to a disparity motion vector and added to the merge candidate list. Note that IMPC is typically a candidate containing motion vectors referring to temporal reference pictures.

* Spatial merging candidates derived from neighbouring prediction unit (PU) partitions are added to the merge candidate list. This process is similar to that in HEVC, where redundant candidates among the initial available spatial candidates are eliminated from the merging list by comparing motion information of candidates. Figure 2 depicts the spatial neighbours (A1, B1, B0, A0, B2) which are the potential candidates for the merging list.
* Other motion vector merging candidates (including temporal/combined bi-predictive/zero motion vector merging candidates) are added to the merge candidate list if the number of valid candidates is less than the maximum number.



Figure . Derivation of inter-view predicted motion candidate for merge mode [1].



Figure . Spatial neighbors which are the potential candidates for the merge list. Arrows indicate which spatial candidate(s) are to be compared [3].

The current design may have the following problem, i.e., 1) IPMC always has a higher priority than disparity motion vector candidate, 2) the candidate introduced by the inter-view motion prediction may be identical with the valid spatial merging candidates, 3) the disparity vector may be not accurate enough which will result in sub-optimal candidates. Therefore, further coding efficiency improvement can be expected by including more candidates derived from IMP and removal of duplicate candidates among the candidates introduced by IMP and spatial candidates.

# Proposed Method

It is proposed that up to three additional candidates might be added into the merge candidate list with pruning. The disparity vector is always converted to a disparity motion vector and added into the merge candidate list. In addition, two (left/right) shifted disparity vectors are created to generate two additional candidates to be added to the merge candidate list. Additional pruning operations are performed to remove identical ones.

## Insertion of the disparity motion vector

When IMPC is available, the disparity vector is converted to a disparity motion vector and further added into the merge candidate list right after IMPC and before all the spatial merging candidates.

## Insertion of the additional candidates derived from shifted disparity vector

After the corresponding block of the base view is identified by the disparity vector, the left and right prediction units (PU) of the PU containing the corresponding block are located and two shifted disparity vectors are derived if applicable:

* Left shifted Disparity Vector (LDV): subtract the disparity vector by the width of the left PU for the horizontal component.
* Right shifted Disparity Vector (RDV): add the disparity vector by the width of the PU containing the corresponding block in the horizontal component

The usage of the LDV/RDV to derive a merge candidate is the same as the disparity vector in the current 3D-HEVC. If Inter-view Predicted Motion Candidate (IPMC) based on the shifted disparity vector is available, the new IPMC is used to be added into the merge candidate list, otherwise, the shifted disparity vector is converted to a disparity motion vector to be added into the merge candidate list.

The derived additional candidates are inserted to the merge candidate list after all the spatial merging candidates. The candidate derived from LDV precedes that derived from RDV.

## Pruning

To improve the coding efficiency while keep the complexity increase relatively small, duplicated candidates may be removed with limited additional number of pruning operations. In the proposed method, only the spatial merging candidates derived from A1 and B1 are compared with the candidates derived from the original/shifted disparity vectors.

## Description of the whole process

To generate a merge candidate list, the following steps are performed in order: (newly introduced steps are highlighted)

1. A disparity vector is derived and the corresponding block of current PU based on the disparity vector is identified. IPMC, if derived to be available, is added to the merge candidate list.
2. Disparity motion vector converted from the disparity vector is added to the merge candidate list right after the IPMC (if IPMC is not available, it is the first one in the list).
3. Spatial merging candidates (SMC) are added to the merge candidate list as current design.
   1. In addition, during SMC generation process, if a SMC derived from A1 or B1 is the same as the IPMC or the disparity motion vector candidate, they are excluded from the merge candidate list.
4. Up to two candidates are derived from LDV and RDV and are inserted into the merge candidate list after pruning.
   1. These two candidates are compared with previously added IPMC or disparity motion vector candidate, and SMCs derived from A1 and B1.
5. Other motion vector merging candidates are added to the merge candidate list if the number of valid candidates is less than the maximum number.

It should be noted that step 1, 3 (excluding 3.a) and 5 are the same as in the current 3D-HEVC and the candidate list size is not changed (still six), once there are enough candidates in the candidate list, no more candidates will be further added.

# Compression Performance

This section provides simulation results of the proposed merge improvement in comparison with the 3DV-HTM anchor. The platform 3D-HTM 4.0.1 [4] is utilized and the proposed method is implemented on top of it. All the simulation tests are performed based on the common test conditions [5].

As shown in Table 1, the overall average bitrate reduction is 0.5%, 0.3%, 0.4% for decoded texture views, synthesized views, coded and synthesized views, respectively.

Table : Coding gain with respect to anchor for 3-view case

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Video  1 | Video  2 | Video  only | Synthesized  only | Coded &  synthesized | Enc  time | Dec  time | Ren  time |
| Balloons | -1.2% | -1.3% | -0.6% | -0.4% | -0.4% | 97.6% | 101.1% | 98.2% |
| Kendo | -1.5% | -1.6% | -0.7% | -0.5% | -0.6% | 97.2% | 94.8% | 91.7% |
| Newspapercc | -0.9% | -0.7% | -0.4% | -0.2% | -0.2% | 95.5% | 91.7% | 93.6% |
| GhostTownFly | -1.7% | -1.8% | -0.7% | -0.4% | -0.5% | 94.6% | 94.8% | 96.5% |
| PoznanHall2 | -0.2% | -0.5% | -0.3% | -0.1% | -0.1% | 102.9% | 91.4% | 99.2% |
| PoznanStreet | -1.7% | -1.0% | -0.5% | -0.4% | -0.5% | 97.3% | 97.9% | 92.9% |
| UndoDancer | -1.0% | -1.1% | -0.4% | -0.4% | -0.4% | 98.5% | 96.2% | 97.6% |
| 1024x768 | -1.2% | -1.2% | -0.6% | -0.4% | -0.4% | 96.7% | 95.8% | 94.4% |
| 1920x1088 | -1.1% | -1.1% | -0.5% | -0.3% | -0.4% | 98.3% | 95.0% | 96.5% |
| **average** | **-1.2%** | **-1.1%** | **-0.5%** | **-0.3%** | **-0.4%** | **97.6%** | **95.4%** | **95.6%** |

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# Patent rights declaration(s)

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