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## **3D-CE5.h: Merge candidate list for disparity compensated prediction**

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**Title:** CE5.h: Merge candidate list for disparity compensated prediction

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**Purpose:** Proposal

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## Abstract

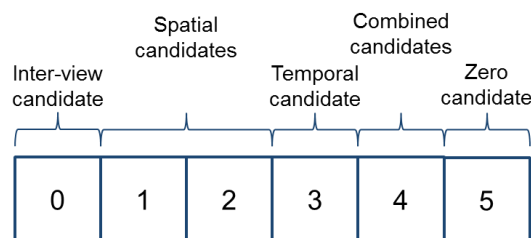
HEVC implements a candidate vector list for merge and skip modes. The construction of this list has been extensively studied in the JCT-VC group (see for instance JCTVC-G039). It has been shown in JCTVC-I0293 that it is possible to improve the HEVC coding performance by adding in the merge list copies 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.

## 1 Introduction

HEVC relies on a candidate vector list for merge and skip modes. The efficiency of this approach depends highly on the relevance of the vectors present in the list. The construction of this list has been extensively studied [1]. During the 9th JCT-VC meeting, it has been shown in [2] 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. More precisely, in [2], if there is available space in the candidate vector list, up to two new candidates are added: the first vector of the list shifted by an offset of  $(-4; 0)$  and  $(4; 0)$ . It corresponds to a horizontal shift of -1 and 1 pixel respectively. In the context of video encoding of multiple rectified views, having a fine horizontal adjustment may be desirable for efficient disparity compensated prediction. Therefore, it is proposed to replace some candidates in the merge list with candidates pointing to the base view and shifted by horizontal offsets.

This document is the follow up of JCT3V-A0134 [3], as part of the core experiment CE5.h. It provides an updated description of the proposed method and results of the integration into HTM 4.0.1. A cross-check is available in JCT3V-B0098.

## 2 Proposed method



**Figure 1: Candidate vector list for merge and skip mode example.**

Figure 1 depicts a typical example of motion vector candidate list. Each motion vector candidate is defined as

- the luma motion vectors  $mvL0$  and  $mvL1$ ,
- the reference indices  $refIdxL0$  and  $refIdxL1$ ,
- the prediction list utilization flags  $predFlagL0$  and  $predFlagL1$ .

The candidate list construction proceeds as follows.

1. Construct the list as currently specified (example result depicted on Figure 1).
2. **Scan the list from the first to the fourth position.** The first candidate found in the list during this scan which has either its L0 vector or L1 vector or both pointing to another view is marked as *selected candidate* (see for example Figure 2). A vector  $mvLX$  is pointing to another view if the  $viewId$  of current coding unit is not equal to the  $viewId$  of reference  $refIdxLX$ . **If no such candidate exists, the process ends.**
3. Let  $m$  be the index of the selected candidate. The index  $m$  is greater or equal to 0 and lower or equal to 3. The selected candidate is defined by  $mvL0_m$ ,  $mvL1_m$ ,  $refIdxL0_m$ ,  $refIdxL1_m$ ,  $predFlagL0_m$ , and  $predFlagL1_m$ . Two refined candidates  $candDCPa$  and  $candDCPb$  are constructed as follows:
  - a. **If**  $mvL0_m$  is pointing to another view:
    - $mvL0candDCPa = mvL0_m + (4, 0)$
    - $mvL1candDCPa = mvL1_m$
    - $refIdxL0candDCPa = refIdxL0_m$
    - $refIdxL1candDCPa = refIdxL1_m$
    - $predFlagL0candDCPa = predFlagL0_m$
    - $predFlagL1candDCPa = predFlagL1_m$
  - b. **Else** ( $mvL1_m$  vector is pointing to another view):
    - $mvL0candDCPa = mvL0_m$
    - $mvL1candDCPa = mvL1_m + (4, 0)$
    - $refIdxL0candDCPa = refIdxL0_m$
    - $refIdxL1candDCPa = refIdxL1_m$
    - $predFlagL0candDCPa = predFlagL0_m$

- $\text{predFlagL1candDCPa} = \text{predFlagL1}_m$
- $\text{mvL0candDCPb} = \text{mvL0}_m$
- $\text{mvL1candDCPb} = \text{mvL1}_m + (-4, 0)$
- $\text{refIdxL0candDCPb} = \text{refIdxL0}_m$
- $\text{refIdxL1candDCPb} = \text{refIdxL1}_m$
- $\text{predFlagL0candDCPb} = \text{predFlagL0}_m$
- $\text{predFlagL1candDCPb} = \text{predFlagL1}_m$

4. Write the two refined candidates in the list as follows:

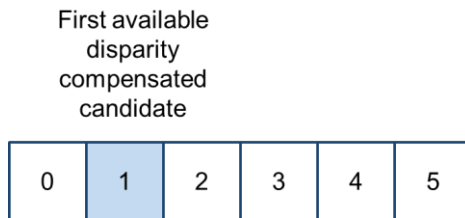
a. **If**  $m < 3$  (illustrated by Figure 3 and Figure 4)

- $\text{mvL0}_5 = \text{mvL0}_3$
- $\text{mvL1}_5 = \text{mvL1}_3$
- $\text{refIdxL0}_5 = \text{refIdxL0}_3$
- $\text{refIdxL1}_5 = \text{refIdxL1}_3$
- $\text{predFlagL0}_5 = \text{predFlagL0}_3$
- $\text{predFlagL1}_5 = \text{predFlagL1}_3$
  
- $\text{mvL0}_3 = \text{mvL0candDCPa}$
- $\text{mvL1}_3 = \text{mvL1candDCPa}$
- $\text{refIdxL0}_3 = \text{refIdxL0candDCPa}$
- $\text{refIdxL1}_3 = \text{refIdxL1candDCPa}$
- $\text{predFlagL0}_3 = \text{predFlagL0candDCPa}$
- $\text{predFlagL1}_3 = \text{predFlagL1candDCPa}$
  
- $\text{mvL0}_4 = \text{mvL0candDCPb}$
- $\text{mvL1}_4 = \text{mvL1candDCPb}$
- $\text{refIdxL0}_4 = \text{refIdxL0candDCPb}$
- $\text{refIdxL1}_4 = \text{refIdxL1candDCPb}$
- $\text{predFlagL0}_4 = \text{predFlagL0candDCPb}$
- $\text{predFlagL1}_4 = \text{predFlagL1candDCPb}$

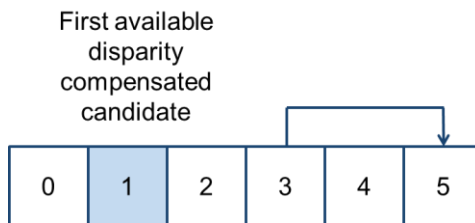
b. **Else** ( $m = 3$ , illustrated by Figure 5)

- $\text{mvL0}_4 = \text{mvL0candDCPa}$
- $\text{mvL1}_4 = \text{mvL1candDCPa}$

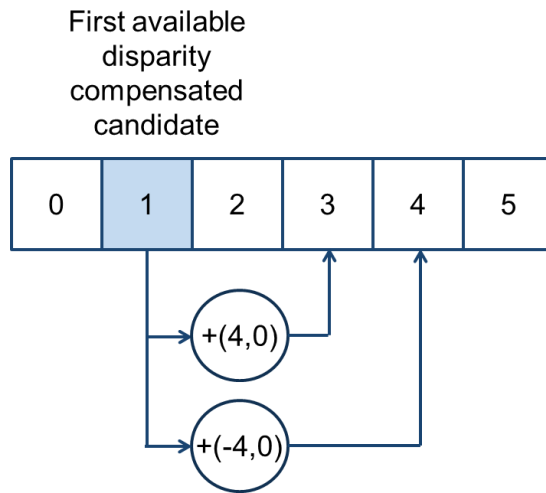
- $\text{refIdxL0}_4 = \text{refIdxL0candDCPa}$
- $\text{refIdxL1}_4 = \text{refIdxL1candDCPa}$
- $\text{predFlagL0}_4 = \text{predFlagL0candDCPa}$
- $\text{predFlagL1}_4 = \text{predFlagL1candDCPa}$
  
- $\text{mvL0}_5 = \text{mvL0candDCPb}$
- $\text{mvL1}_5 = \text{mvL1candDCPb}$
- $\text{refIdxL0}_5 = \text{refIdxL0candDCPb}$
- $\text{refIdxL1}_5 = \text{refIdxL1candDCPb}$
- $\text{predFlagL0}_5 = \text{predFlagL0candDCPb}$
- $\text{predFlagL1}_5 = \text{predFlagL1candDCPb}$



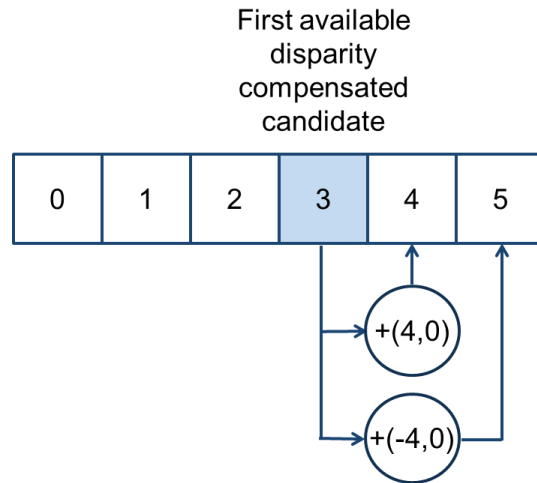
**Figure 2: Selection of a disparity compensated candidate.**



**Figure 3: Displacement of the fourth candidate to the last position in the candidate list.**



**Figure 4: Overwriting of fourth and fifth candidates by newly generated candidates.**



**Figure 5: Overwriting of fifth and last candidates by newly generated candidates**

### 3 Experimental results

The experiment has been conducted with HTM 4.0.1 and evaluation is based on common test conditions [4].

Results are provided in Table 1.

**Table 1: Results obtained with HTM 4.0.1 and Merge list extension with DCP candidate, compared to HTM 4.0.1**

|                | video 0     | video 1      | video 2      | video only   | synthesized only | coded & synthesized | enc time     | dec time      |
|----------------|-------------|--------------|--------------|--------------|------------------|---------------------|--------------|---------------|
| Balloons       | 0,0%        | 0,0%         | 0,0%         | 0,0%         | 0,0%             | 0,0%                | 96,8%        | 101,1%        |
| Kendo          | 0,0%        | -0,2%        | -0,3%        | -0,1%        | 0,0%             | -0,1%               | 97,0%        | 101,2%        |
| Newspapercc    | 0,0%        | -0,5%        | -0,5%        | -0,2%        | 0,0%             | -0,1%               | 96,9%        | 99,0%         |
| GhostTownFly   | 0,0%        | -1,1%        | -0,8%        | -0,3%        | -0,2%            | -0,2%               | 97,3%        | 101,5%        |
| PoznanHall2    | 0,0%        | 0,2%         | -0,3%        | -0,1%        | -0,1%            | -0,1%               | 97,9%        | 99,2%         |
| PoznanStreet   | 0,0%        | -0,5%        | -0,3%        | -0,2%        | -0,1%            | -0,2%               | 95,6%        | 100,5%        |
| UndoDancer     | 0,0%        | -0,3%        | -0,2%        | -0,1%        | -0,1%            | -0,1%               | 96,9%        | 100,9%        |
| 1024x768       | 0,0%        | -0,2%        | -0,3%        | -0,1%        | 0,0%             | 0,0%                | 96,9%        | 100,4%        |
| 1920x1088      | 0,0%        | -0,4%        | -0,4%        | -0,2%        | -0,1%            | -0,1%               | 96,9%        | 100,5%        |
| <b>average</b> | <b>0,0%</b> | <b>-0,3%</b> | <b>-0,3%</b> | <b>-0,1%</b> | <b>-0,1%</b>     | <b>-0,1%</b>        | <b>96,9%</b> | <b>100,5%</b> |

## 4 Conclusion

Given the reported gains with no added complexity, we suggest to adopt the proposed method.

## 5 References

- [1] Benjamin Bross, Joel Jung, “CE9: Summary Report of Core Experiment on MV Coding and Skip/Merge Operations”, JCTVC-G039, JCT-VC 7th Meeting, Geneva, CH, 21-30 November, 2011.
- [2] Tomoyuki Yamamoto, Tomohiro Ikai, “Merge candidate refinement for uni-predictive block”, JCTVC-I0293, JCT-VC 9<sup>th</sup> meeting, Geneva, CH, 27 April – 7 May 2012.
- [3] Thomas Guionnet, Laurent Guillo, Christine Guillemot, « CE5.h related: Merge candidate list extension for disparity compensated prediction», JCT3V-A0134, July 2012, Stockholm, Sweden.
- [4] Dmytro Rusanovskyy, Karsten Müller, Anthony Vetro, « Common test conditions for 3DV Core Experiments », JCT3V-A1100, July 2012, Stockholm, Sweden.

## 6 Patent rights declaration(s)

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