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| **Joint Collaborative Team on 3D Video Coding Extensions**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  4th Meeting: Incheon, KR, 20–26 Apr. 2013 | Document: JCT3V-D0064r1 |

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| *Title:* | **AHG13: Parallel decoding SEI message** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Proposal | | |
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# Abstract

At the last meeting, the normative disparity vector constraints are incorporated in Stereo profile of MV-HEVC to enable parallel decoding. The utilization of constraints is explicitly signalled in SPS. The flag guarantees disparity vector restriction between the target view and all reference views. Although this general constraint flag is thought to be effective in practical usage, there are other cases that more specific constraint signalling is needed where the disparity vectors related to some reference views are restricted and the disparity vectors related to other reference views are not restricted. This contribution proposes a parallel decoding SEI message which can deliver such specific constraint.

# Motivation

**Two-dimensional case**

In most practical usage, one-dimensional camera arrangement case as shown in Figure 1, all disparity vectors between target view and reference views can be restricted. If the SPS flag which was adopted in the last meeting is used, the decoder safely decodes all views in parallel. Thus one stage decoding is applicable.



Figure1 One-dimensional camera arrangement case

However, two-dimensional camera arrangement case, some disparity vectors between target view and reference view (ex. View 3 and View 0 in Figure 2) could not be strictly restricted as required in the SPS flag because the vertical disparity vector range is usually larger than the requiredrange. Nevertheless the disparity vector between target view and some reference view (ex. View 4 and View 3 in Figure 2) can be restricted. In this situation, we can apply parallel decoding in View 3 and View 4 (stage 2) as well as the case View0 and View1 (stage 1).

To utilize such parallelization, a specific signalling in which disparity vector range between each reference views can be indicated is required.



Figure 2 Two-dimensional camera arrangement case

**Ultra-low delay case**

Assuming the case View 0 is located on the left side of View 1 (where horizontal disparity vector is minus and vertical disparity vector is zero) and loop filter of both DF and SAO is disabled in View 0, View 0 and View 1 can be decoded in CTB delay. This allows ultra-low delay decoding and also provides a chance that decoding performance is improved because View 1 decoder can load View 0 decoded image not from external memory but cached memory that View 0 decoder just produced.



Figure 3 Ultra low delay case

# Proposal

The proposed SEI has the capability that indicates constraints between target view and each reference views. Also the SEI has the capability that indicates one CTB delay case.

In the proposal, the unreferenced regions is specified relative to the current CTB address (xCtb, yCtb) and it can consist of two unreferenced regions, unreferenced region I and unreferenced region II as shown in Figure 4 and Figure 5 respectively. In the case that only vertical disparity range is restricted, the unreferenced region I is defined. In the case that both of horizontal disparity vector and vertical disparity vector is used the unreferenced region I and unreferenced region II is defined in Figure 6.

A syntax element **pdi\_unreferenced\_region\_ctu\_vertical** in the SEI specifies the unreferenced regions I.

Syntax elements **pdi\_ unreferenced\_region\_ctu\_horizontal** and **pdi\_unreferenced\_region\_ctu\_vertical** in the SEI specifies the unreferenced regions II.

Syntax element **pdi\_offset\_flag** in the SEI specified the unreference region is specified considering 4 pixel margins consists of loopfilter (3 pixel for DF, 1 pixel for SAO).



Figure 4. Unreferenced region I



Figure 5. Unreferenced region II



Figure 6. Unreferenced region I + II

The unreferenced regions are specified by the data on SEI message and the target view’s parameter current CTB address and CTB size rather than reference view’s parameter. Therefore the encoder easily understands their unreferenced region. Initial decoding delay of target view decoding relative to reference view decoding is realized as follows.

vertical initial decoding delay = pdi\_unreferenced\_region\_ctu\_vertical

horizontal initial decoding delay = pdi\_unreferenced\_region\_ctu\_horizontal > 0 : pdi\_unreferenced\_region\_ctu\_horizontal : PicWidthInCtbsX - xCtb

Specifically, the CTB cordinate of reference view, (xRefCtb, yRefCtb), that shall be decoded before the target view CTB of (xCtb, yCtb) is defined as follows.

xRefCtb = ((xCtb + pdi\_unreferenced\_region\_ctu\_horizontal \* CtbSizeY + refCtbSizeY - 1) / refCtbSizeY - 1) \* refCtbSizeY

yRefCtb = ((yCtb + (pdi\_unreferenced\_region\_ctu\_vertical + 1) \* CtbSizeY + refCtbSizeY - 1) / refCtbSizeY - 1) \* refCtbSizeY

Note : The key point of this SEI is to clearly define the unreferenced region. The proposed definition not need to care about reference view’s parameter so it thought to be very clear.

The comparison between our method and JCT3V-C0062r1[1] or JCT3V-D0199[4] are summarized in Table 1.

Table 1 Comparison with JCT3V-C0062r1

|  |  |  |
| --- | --- | --- |
|  | Proposal | JCT3V-C0062r1 (D0199) |
| Multi restriction case  (such as two-dimensional case) | OK | OK |
| Ultra low relay restriction | OK | NG |
| Vertical only restriction | OK | NG |
| CTB size mismatch between target view and reference views | OK | OK |
| Unreferenced regin definition | More clear  (reference CTB size independent) | Relatively not clear  (reference CTB size dependent) |

# Proposed Text

## Parallel decoding information SEI message syntax

|  |  |
| --- | --- |
| parallel\_decoding\_info( payloadSize ) { | Descriptor |
| **video\_parameter\_set\_id** | ue(v) |
| **pdi\_offset\_flag** | u(1) |
| for( i = 1; i <= num\_views\_minus1; i++ ) { |  |
| for( j = 0; j < num\_direct\_ref\_layers[ i ]; j++ ) { |  |
| **pdi\_unreferenced\_region\_ctu\_vertical[ i ][ j ]** | ue(v) |
| if (pdi\_unreferenced\_region\_ctu\_vertical) |  |
| **pdi\_unreferenced\_region\_ctu\_horizontal [ i ][ j ]** | ue(v) |
| } |  |
| } |  |
| } |  |

## Parallel decoding information SEI message semantics

The parallel decoding information SEI message may be associated with any access unit. The information signalled in the SEI message applies to all the access units from the access unit the SEI message is associated with to the next access unit, in decoding order, containing an SEI message of the same type, exclusively, or to the end of the coded video sequence, whichever is earlier in decoding order.

Some view components for which the parallel decoding information is signalled in a parallel decoding information SEI message may not be present in the coded video sequence.

**video\_parameter\_set\_id** specifies a video parameter set that contains the inter-view dependency relationship information. The value of video\_parameter\_set\_id shall be equal to the value of video\_parameter\_set\_id referenced by a view component of the coded picture of the access unit containing the parallel decoding information SEI message.

**pdi\_offset\_flag** specify the offset value which is used in specification of unavailable reference areas. The variable PdiOffsetVal is set equal to pdi\_offset\_flag \* 4.

**pdi\_unreferenced\_region\_ctu\_vertical[ i ][ j ]** larger than 0 specify an unavailable reference area in the j-th reference view component of i-th coded view component which shall not be used for inter-view reference by the i-th coded view component that uses inter-view prediction specified in the active video parameter set identified by video\_parameter\_set\_id. The range of pdi\_unit\_delay\_ctu\_vertical[ i ][ j ] shall be 0 to PicHeightInCtbs  ‑ 1, inclusive.

The unavailable reference area in the j-th reference view of the coded view component i is the rectangle area [x][y] where

x = 0..pic\_width\_in\_luma\_samples − 1,

y = yCtb + (pdi\_unreferenced\_region\_ctu\_vertical<<CtbLog2SizeX) - PdiOffsetVal..pic\_height\_in\_luma\_samples − 1.

yCtb = ( CtbAddrInRs / PicWidthInCtbsY ) << CtbLog2SizeY

**pdi\_unreferenced\_region\_ctu\_horizontal[ i ][ j ]** larger than 0 specify an additional unavailable reference area in the j-th reference view component of i-th coded view component which shall not be used for inter-view reference by the i-th coded view component that uses inter-view prediction specified in the active video parameter set identified by video\_parameter\_set\_id. The range of pdi\_unit\_delay\_ctu\_horizontal[ i ][ j ] shall be 0 to PicWidthInCtbs  ‑ 1,inclusive.

The additional unavailable reference area in the j-th reference view of the coded view component i is the rectangle area [x][y] where

x = xCtb+ (pdi\_unreferenced\_region\_ctu\_horizontal<<CtbLog2SizeX) - PdiOffsetVal..pic\_width\_in\_luma\_samples − 1,

y = yCtb+(pdi\_unreferenced\_region\_ctu\_vertical–1)<<CtbLog2SizeY)- PdiOffsetVal..pic\_height\_in\_luma\_samples − 1.

xCtb = ( CtbAddrInRs % PicWidthInCtbsY ) << CtbLog2SizeY

yCtb = ( CtbAddrInRs / PicWidthInCtbsY ) << CtbLog2SizeY

# Conclusion

This contribution proposes a parallel decoding SEI message which can deliver such specific constraint. It is recommended to adopt this method in the next MV-HEVC and 3D-HEVC.

# References

[1] Y. Chen, V. Seregin, A.-K. Ramasubramonian, L. Zhang, Y.-K. Wang, “AHG7: Parallel decoding SEI message for MV-HEVC”, JCT3V-C0062r1, JCT3V 3rd Meeting: Geneva, CH, 17–23 Jan. 2013

[2] G. Tech, K. Wegner, Y. Chen, M. Hannuksela, J. Boyce, “MV-HEVC Draft Text 3 (ISO/IEC 23008-2 PDAM2)”, JCT3V-C1004, JCT3V 3rd Meeting: Geneva, CH, 17–23 Jan. 2013

[3] G. Tech, K. Wegner, Y. Chen, S. Yea, “3D-HEVC Test Model 3”, JCT3V-C1005, JCT3V 3rd Meeting: Geneva, CH, 17–23 Jan. 2013

[3] [Y. Chen](mailto:cheny@qti.qualcomm.com), [A. K. Ramasubramonian](mailto:aramasub@qti.qualcomm.com), [Y.-K. Wang](mailto:yekuiw@qti.qualcomm.com), S. Seregin, L. Zhang, “AHG7: Parallel decoding SEI message for MV-HEVC” , JCT3V-D0199, JCT3V 4th Meeting: Incheon, KR, 20–26 Apr. 2013

# Patent rights declaration(s)

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