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| *Title:* | **3D-CE2.a results on simplification on the disparity vector derivation** | | |
| *Status:* | Input Document to JCT-3V | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution presents the results of the simplified method for disparity vector derivation in Inter mode proposed by ETRI and KHU in JCT3V-B0073 [1].

For the half resolution depth and the full resolution depth experiment, the proposed algorithm is tested on inter-view motion vector prediction and temporal motion vector prediction combination. The result is shown that the performance is almost same in aspect of texture and synthesized’s BD performances, respectively. Whereas, the encoding time and the decoding time are saved together around 1% in the half resolution depth.

Consequently, the purpose of the proposed algorithm is to save the memory access bandwidth in the disparity vector derivation process with sharing only one depth sample in each sub-block of MB. It is indicated that the proposed approach removes the searching and the comparison operations to find maximum depth sample in each sub-blocks, and additionally reduces the encoder complexity.

# Introduction

In the last meeting, a simplified disparity vector derivation method was proposed by ETRI and KHU [1] to reduce the memory access bandwidth using only one depth sample in a 16x16 MB.



Fig. 1 Derivation of the depth value in case a 16x16 MB is partitioned into 4x4 partitions

The 4x4 partition case of the proposed method is shown in . In Fig.1, a common depth sample (green pixel) of a right-bottom corner of 16x16 MB is given at every 4x4 partition blocks instead of the different depth samples (gray pixel). Thus, all the partitions inside a 16x16 MB take only one depth sample for deriving the disparity vector.

In our contribution, an additional modification is required because the proposal “the depth based motion vector prediction method in temporal motion vector prediction” from Samsung Electronics Co. Ltd [2] was adopted at the last meeting. The disparity vector derivation of the temporal motion vector prediction and the inter-view motion is identical in processing. So, temporal motion vector prediction has also same problem associated with memory access bandwidth.

Therefore, the proposed method was implemented for the disparity vector derivation of the inter-view motion vector prediction and the temporal motion vector prediction, respectively.

Main advantages of the proposed method can be described as follows:

1. Memory access bandwidth reduction: significantly reduce the number of the depth samples to be accessed (in worst case, from 64 to 1 as shown in Table 1.)
2. Remove the searching operation of the depth samples according to the different partition size
3. Remove the comparing operation of the depth samples
4. Minor coding loss

* 0.05% and 0.02% BD-rate increase for texture and synthesized views, respectively for half resolution depth.
* 0.07% and 0.04% BD-rate increase for texture and synthesized views, respectively for full resolution depth.

1. Complexity Reduction for encoding
2. Simple WD text

Table . Comparison of the number of the depth samples to be accessed in a 16x16 MB

|  |  |  |
| --- | --- | --- |
| partition size | ATM6.0 | Proposed Method |
| 16x16 partitions | 4 | 1 |
| 8x8 partitions | 16 | 1 |
| 4x4 partitions | 64 | 1 |

# Simulation Results

Common test conditions specified in JCT2-B1100 [3] is used for the evaluation. Two cases (the proposed algorithm applied for the inter-view motion vector prediction, temporal motion vector prediction) were simulated both separately and together. In addition, the simulation was performed with full depth resolution as well as half depth resolution.

The following shows test sets.

Table 2. Test sets

|  |  |  |  |
| --- | --- | --- | --- |
|  | Inter  (Inter-view) | Inter  (Temporal) | Depth  Resolution |
| Test 1.H | Bottom right | N/A | Half |
| Test 1.F | Bottom right | N/A | Full |
| Test 2.H | N/A | Bottom right | Half |
| Test 2.F | N/A | Bottom right | Full |
| Test 3.H | Bottom right | Bottom right | Half |
| Test 3.F | Bottom right | Bottom right | Full |

The following tables show the simulation results of the test cases. The proposed method brings slight BD rate loss. Encoding time is not reliable because all sequences were encoded in parallel.

The following table 2 shows the summary of the results of the proposed methods.

Table 3. Summary of the results of the proposed method

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total  (Synthesized PSNR) | | Complexity estimate (ratio to anchor) | |
|  | dBR | dPSNR | dBR | dPSNR | dBR | dPSNR | dBR | dPSNR | Enc. time | Dec. time |
| Test.1 H | 0.06 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.03 | 0.00 | 100% | 100% |
| Test.1 F | 0.08 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.03 | 0.00 | 100% | 100% |
| Test.2 H | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 99% | 100% |
| Test.2 F | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100% | 101% |
| Test.3 H | 0.05 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 99% | 99% |
| Test.3 F | 0.08 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.04 | 0.00 | 100% | 101% |

The following tables show the simulation results of the test cases.

Table . Result of the Test 1.H (Inter-view, Half resolution depth)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total (Synthesed PSNR) | | Complexity estimate  (ratio to anchor) | | |
|  | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | Encoder Time, % | Decoder Time, % | Rendering Time, % |
| S01 | -0.04 | 0.00 | 0.00 | 0.00 | -0.05 | 0.00 | -0.02 | 0.00 | 99% | 100% | 100% |
| S02 | 0.09 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.04 | 0.00 | 99% | 100% | 100% |
| S03 | 0.10 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.04 | 0.00 | 99% | 100% | 100% |
| S04 | 0.15 | -0.01 | 0.00 | 0.00 | 0.14 | -0.01 | 0.10 | 0.00 | 99% | 100% | 100% |
| S05 | 0.10 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.02 | 0.00 | 100% | 100% | 100% |
| S06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | -0.01 | 0.00 | 100% | 100% | 100% |
| S08 | -0.01 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.01 | 0.00 | 100% | 100% | 100% |
| Average | 0.06 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.03 | 0.00 | 100% | 100% | 100% |

Table 5. Result of the Test 1.F (Inter-view, Full resolution depth)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total (Synthesed PSNR) | | Complexity estimate  (ratio to anchor) | | |
|  | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | Encoder Time, % | Decoder Time, % | Rendering Time, % |
| S01 | -0.05 | 0.00 | 0.00 | 0.00 | -0.04 | 0.00 | -0.06 | 0.00 | 98% | 100% | 100% |
| S02 | 0.12 | 0.00 | 0.00 | 0.00 | 0.11 | 0.00 | 0.06 | 0.00 | 94% | 100% | 100% |
| S03 | 0.10 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.02 | 0.00 | 99% | 100% | 100% |
| S04 | 0.15 | -0.01 | 0.00 | 0.00 | 0.14 | 0.00 | 0.09 | 0.00 | 91% | 100% | 100% |
| S05 | 0.09 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.06 | 0.00 | 95% | 100% | 100% |
| S06 | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | -0.02 | 0.00 | 108% | 100% | 100% |
| S08 | 0.10 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.06 | 0.00 | 115% | 100% | 100% |
| Average | 0.08 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.03 | 0.00 | 100% | 100% | 100% |

Table 6. Result of the Test 2.H (Temporal, Half resolution depth)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total (Synthesed PSNR) | | Complexity estimate  (ratio to anchor) | | |
|  | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | Encoder Time, % | Decoder Time, % | Rendering Time, % |
| S01 | 0.06 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.04 | 0.00 | 100% | 101% | 100% |
| S02 | 0.02 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 | 0.03 | 0.00 | 102% | 101% | 100% |
| S03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 102% | 102% | 100% |
| S04 | -0.01 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | -0.01 | 0.00 | 102% | 101% | 100% |
| S05 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | -0.03 | 0.00 | 96% | 100% | 100% |
| S06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 97% | 97% | 100% |
| S08 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 97% | 98% | 100% |
| Average | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 99% | 100% | 100% |

Table 7. Result of the Test 2.F (Temporal, Full resolution depth)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total (Synthesed PSNR) | | Complexity estimate  (ratio to anchor) | | |
|  | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | Encoder Time, % | Decoder Time, % | Rendering Time, % |
| S01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 102% | 101% | 100% |
| S02 | -0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 102% | 102% | 100% |
| S03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | -0.01 | 0.00 | 105% | 100% | 100% |
| S04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 103% | 101% | 100% |
| S05 | -0.03 | 0.00 | 0.00 | 0.00 | -0.03 | 0.00 | -0.01 | 0.00 | 85% | 99% | 100% |
| S06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 103% | 102% | 100% |
| S08 | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.02 | 0.00 | 98% | 104% | 100% |
| Average | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100% | 101% | 100% |

Table 8. Result of the Test 3.H (Inter-view + Temporal, Half resolution depth)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total (Synthesed PSNR) | | Complexity estimate  (ratio to anchor) | | |
|  | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | Encoder Time, % | Decoder Time, % | Rendering Time, % |
| S01 | -0.02 | 0.00 | 0.00 | 0.00 | -0.02 | 0.00 | -0.01 | 0.00 | 99% | 101% | 100% |
| S02 | 0.08 | 0.00 | 0.00 | 0.00 | 0.08 | 0.00 | 0.04 | 0.00 | 100% | 102% | 100% |
| S03 | 0.10 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.05 | 0.00 | 100% | 97% | 100% |
| S04 | 0.12 | 0.00 | 0.00 | 0.00 | 0.12 | 0.00 | 0.07 | 0.00 | 99% | 102% | 100% |
| S05 | 0.07 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | -0.01 | 0.00 | 98% | 99% | 100% |
| S06 | 0.02 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 | 99% | 96% | 100% |
| S08 | 0.00 | 0.00 | 0.00 | 0.00 | -0.01 | 0.00 | 0.01 | 0.00 | 99% | 99% | 100% |
| Average | 0.05 | 0.00 | 0.00 | 0.00 | 0.05 | 0.00 | 0.02 | 0.00 | 99% | 99% | 100% |

Table 9. Result of the Test 3.F (Inter-view + Temporal, Full resolution depth)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Texture Coding | | Depth Coding | | Total (Coded PSNR) | | Total (Synthesed PSNR) | | Complexity estimate  (ratio to anchor) | | |
|  | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | dBR, % | dPSNR,dB | Encoder Time, % | Decoder Time, % | Rendering Time, % |
| S01 | -0.06 | 0.00 | 0.00 | 0.00 | -0.04 | 0.00 | -0.07 | 0.00 | 101% | 101% | 100% |
| S02 | 0.15 | 0.00 | 0.00 | 0.00 | 0.13 | 0.00 | 0.08 | 0.00 | 105% | 102% | 100% |
| S03 | 0.12 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.04 | 0.00 | 104% | 100% | 100% |
| S04 | 0.15 | -0.01 | 0.00 | 0.00 | 0.13 | 0.00 | 0.08 | 0.00 | 102% | 101% | 100% |
| S05 | 0.10 | -0.01 | 0.00 | 0.00 | 0.10 | 0.00 | 0.08 | 0.00 | 92% | 99% | 100% |
| S06 | 0.02 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | -0.02 | 0.00 | 99% | 102% | 100% |
| S08 | 0.11 | 0.00 | 0.00 | 0.00 | 0.09 | 0.00 | 0.06 | 0.00 | 95% | 104% | 100% |
| Average | 0.08 | 0.00 | 0.00 | 0.00 | 0.07 | 0.00 | 0.04 | 0.00 | 100% | 101% | 100% |

# Conclusions

The simplified derivation method of the disparity vector was proposed. While the proposed method shows negligible BD rate loss and complexity, it reduces the memory access bandwidth and removes the searching and comparing operation of the depth samples depending on a partition size. So, it is recommended to adopt the proposed method to the next 3DV-ATM and the 3D-AVC WD.

# References

[1] G. Bang, K. Y. Kim, Y. S. Heo, G, H. Park, W. Cheong and N. Hur, “3D-CE5.a related: Simplification on the disparity vector derivation”, 2nd JCT3V Meeting, JCT3V-B0073, Shanghai, CN, Oct. 2012.

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# Patent rights declaration(s)

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