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| *Title:* | **3D-CE6.h related: Fast DMM Selection for Depth Intra Coding** | | | |
| *Status:* | Input Document | | | |
| *Purpose:* | Proposal | | | |
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# Abstract

This contribution proposes further simplifications of mode decision process on HEVC depth intra coding. In this contribution, it is proposed that for most the cases, the DMM full-RD search could be skipped since the most CU is very flat or smooth and DMMs are designed for CU with edge or sharp transition. Using Most Probable Mode (MPM) as the indicator, we proposed two fast DMM selection algorithms to speedup the encoding process. The test result for Method 1 reports 27.8% encoding time saving with 0.31% bitrate increasing in coded and synthesized view for All-Intra test case. The test result for Method 2 reports 14.7% encoding time saving with 0.16% bitrate increasing in coded and synthesized view for All-Intra test case.

# Introduction

In current 3D-HEVC design[1], DMM is utilized together with the intra coding scheme of HEVC for intra coding of depth map. During the mode selection process, a full RD search list is created and several MPMs (8 for 4x4 and 8x8 CU size, 3 for 16x16, 32x32, 64x64 CU size) are selected from 36 Intra prediction modes for full-RD cost calculation. After selection of several MPMs, all the DMMs are also added to the full-RD search list. It is observed that after full-RD search, DMMs have less than 10% probability to be selected as best mode. This is because most of the CUs in depth map are flat or smooth, and DMMs are designed for CU with edge or sharp transition which is less efficient for smooth CU compression.

# Proposed Solution

Based on this observation, we propose two methods to early terminate the DMM full-RD cost calculation.

## Method 1: Pre-selection based on the first mode in full-RD cost calculation list

It is observed that when the first mode in full-RD cost calculation list is planar mode (uiRdModeList[0] == 0), the CU is very like to be flat or smooth. Therefore, under this condition, all the DMMs full-RD cost calculation are skipped.

## Method 2: Refinement for DMM mode1 and DMM mode3 based on Method 1.

Under the Pre-selection condition in Method 1, most unnecessary DMM full-RD cost calculation is skipped. However, it still misses some cases when DMM is selected as the best mode under that condition. Close survey shows that for those missed DMMs, DMM mode1 without delta CPVs (DMM\_WEDGE\_FULL\_IDX) and DMM mode3 with delta CPVs (DMM\_WEDGE\_PREDTEX \_D\_IDX) are the two most probable DMMs. For these two DMMs, we observe that when they are missed, the second mode in full-RD cost calculation list is very likely to be DC (uiRdModeList[1] == 1).

Based on previous analysis, we summarize conditions required in Method 2 in Figure 1:



Figure 1. Flow chart of Method 2 considering existing conditions

# Experimental Results

The proposed method is implemented on HTM5.1 software.

For Method 1, Table1 shows the coding performance of 3-view case under common test condition [2] for random access. Table2 shows the coding performance of 3-view case for all intra case. It is observed that 27.8% encoding time saving and 0.31% bitrate increasing in coded and synthesized view for all intra case.

For Method 2, Table3 shows the coding performance of 3-view case under common test condition [2] for random access. Table4 shows the coding performance of 3-view case for all intra case. It is observed that 14.7% encoding time saving and 0.16% bitrate increasing in coded and synthesized view for all intra case.

## Test of Method 1

Table 1: BD rate results for 3-view case under CTC, Random Access

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time | ren time |
| Balloons | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.06% | 99.00% | 96.78% | 95.47% |
| Kendo | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.01% | 98.94% | 99.38% | 97.07% |
| Newspapercc | 0.00% | 0.00% | 0.00% | 0.00% | 0.25% | 0.14% | 98.53% | 99.48% | 97.09% |
| GhostTownFly | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.09% | 97.50% | 94.39% | 97.09% |
| PoznanHall2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.15% | 0.09% | 98.87% | 98.43% | 94.60% |
| PoznanStreet | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.04% | 98.77% | 92.81% | 95.64% |
| UndoDancer | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.05% | 99.05% | 99.05% | 97.13% |
| 1024x768 | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.07% | 98.82% | 98.54% | 96.54% |
| 1920x1088 | 0.00% | 0.00% | 0.00% | 0.00% | 0.11% | 0.07% | 98.54% | 96.13% | 96.11% |
| **average** | **0.00%** | **0.00%** | **0.00%** | **0.00%** | **0.11%** | **0.07%** | **98.66%** | **97.16%** | **96.29%** |

Table 2: BD rate results for 3-view case under CTC, ALL Intra

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time | ren time |
| Balloons | 0.00% | 0.00% | 0.00% | 0.00% | 0.49% | 0.31% | 70.02% | 100.91% | 96.68% |
| Kendo | 0.00% | 0.00% | 0.00% | 0.00% | 0.52% | 0.32% | 70.82% | 102.20% | 101.54% |
| Newspapercc | 0.00% | 0.00% | 0.00% | 0.00% | 0.79% | 0.48% | 77.18% | 98.53% | 102.95% |
| GhostTownFly | 0.00% | 0.00% | 0.00% | 0.00% | 0.38% | 0.25% | 76.02% | 99.04% | 97.79% |
| PoznanHall2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.64% | 0.43% | 65.64% | 98.03% | 97.90% |
| PoznanStreet | 0.00% | 0.00% | 0.00% | 0.00% | 0.27% | 0.15% | 70.52% | 102.41% | 95.58% |
| UndoDancer | 0.00% | 0.00% | 0.00% | 0.00% | 0.37% | 0.26% | 75.90% | 99.17% | 97.66% |
| 1024x768 | 0.00% | 0.00% | 0.00% | 0.00% | 0.60% | 0.37% | 72.61% | 100.54% | 100.35% |
| 1920x1088 | 0.00% | 0.00% | 0.00% | 0.00% | 0.41% | 0.27% | 71.89% | 99.65% | 97.23% |
| **average** | **0.00%** | **0.00%** | **0.00%** | **0.00%** | **0.49%** | **0.31%** | **72.20%** | **100.03%** | **98.55%** |

## Test of Method 2

Table 3: BD rate results for 3-view case under CTC, Random Access

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time | ren time |
| Balloons | 0.00% | 0.00% | 0.00% | 0.00% | 0.07% | 0.05% | 99.41% | 100.50% | 97.30% |
| Kendo | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.01% | 99.60% | 99.97% | 97.86% |
| Newspapercc | 0.00% | 0.00% | 0.00% | 0.00% | 0.10% | 0.06% | 98.88% | 97.81% | 97.04% |
| GhostTownFly | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 99.58% | 99.80% | 99.64% |
| PoznanHall2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.15% | 0.09% | 99.72% | 98.83% | 98.50% |
| PoznanStreet | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | 0.00% | 99.89% | 99.33% | 99.18% |
| UndoDancer | 0.00% | 0.00% | 0.00% | 0.00% | 0.08% | 0.05% | 100.19% | 101.54% | 96.48% |
| 1024x768 | 0.00% | 0.00% | 0.00% | 0.00% | 0.06% | 0.03% | 99.29% | 99.42% | 97.40% |
| 1920x1088 | 0.00% | 0.00% | 0.00% | 0.00% | 0.06% | 0.04% | 99.85% | 99.87% | 98.44% |
| **average** | **0.00%** | **0.00%** | **0.00%** | **0.00%** | **0.06%** | **0.04%** | **99.61%** | **99.68%** | **97.99%** |

Table 4: BD rate results for 3-view case under CTC, ALL Intra

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time | ren time |
| Balloons | 0.00% | 0.00% | 0.00% | 0.00% | 0.21% | 0.14% | 84.13% | 101.17% | 98.06% |
| Kendo | 0.00% | 0.00% | 0.00% | 0.00% | 0.26% | 0.16% | 83.52% | 103.34% | 100.74% |
| Newspapercc | 0.00% | 0.00% | 0.00% | 0.00% | 0.37% | 0.23% | 88.43% | 101.27% | 100.25% |
| GhostTownFly | 0.00% | 0.00% | 0.00% | 0.00% | 0.25% | 0.17% | 86.00% | 100.40% | 99.18% |
| PoznanHall2 | 0.00% | 0.00% | 0.00% | 0.00% | 0.29% | 0.20% | 84.57% | 97.67% | 99.06% |
| PoznanStreet | 0.00% | 0.00% | 0.00% | 0.00% | 0.12% | 0.07% | 84.38% | 99.94% | 97.56% |
| UndoDancer | 0.00% | 0.00% | 0.00% | 0.00% | 0.17% | 0.12% | 86.65% | 97.95% | 97.35% |
| 1024x768 | 0.00% | 0.00% | 0.00% | 0.00% | 0.28% | 0.18% | 85.33% | 101.92% | 99.68% |
| 1920x1088 | 0.00% | 0.00% | 0.00% | 0.00% | 0.21% | 0.14% | 85.40% | 98.98% | 98.29% |
| **average** | **0.00%** | **0.00%** | **0.00%** | **0.00%** | **0.24%** | **0.16%** | **85.37%** | **100.23%** | **98.88%** |

# Conclusion

Fast mode selection algorithms of intra depth coding for 3D-HEVC is proposed. The proposed method avoids unnecessary DMM full-RD cost calculation based on the selection MPMs. It is reported that for all intra test, Method 1 achieves 27.8% encoding time saving with 0.31% bitrate lost in coded and synthesized view and Method 2 achieves 14.7% encoding time saving with 0.16% bitrate lost in coded and synthesized view. It is suggested to inlcude the fast DMM selection methods in HTM5.1.

# References

[1] G. Tech, K. Wegner, Y. Chen, S. Yea “3D-HEVC Test Model 2” , JCT3V-B1005, 2nd Meeting: Shanghai, CN , 13–19 Oct. 2012.

[2] D. Rusanovskyy, K. Mueller, A. Vetro, “Common Test Conditions of 3DV Core Experiments” JCT3V-B1100, 2nd Meeting: Shanghai, CN , 13–19 Oct. 2012.

# Patent rights declaration(s)

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