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| *Title:* | **3D-CE6.h related: Fast Intra Prediction Mode Selection for Intra Depth Map Coding** | | | |
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| *Purpose:* | Proposal | | | |
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# Abstract

This contribution proposes simplification of mode decision process on HEVC depth intra coding. In this contribution, it is proposed that for most the cases, the Depth Modelling Mode (DMM)[1] and Region Boundary Chain mode[3] full-RD search could be skipped since the most CU is very flat or smooth and those modes are designed for depth CU with edge or sharp transition. Using the first mode in the full-RD search list and the block variance as indicators, we proposed a fast mode decision algorithm speedup the intra depth map encoding process. The test result reports 23.5% encoding time saving with no bitrate loss for All-Intra test case. 2.3% encoding time saving and 0.1% gain in synthesized views is reported under CTC.

# Introduction

In current 3D-HEVC design[1], DMMs and Region Boundary Chain mode are utilized together with the intra coding modes of HEVC for depth map intra coding. During the mode selection process, a full RD search list is created and several intra prediction modes are selected from all intra prediction modes for full-RD cost calculation. Then all the DMMs and Region Boundary Chain modes are also added to the full-RD search list. It is observed that after full-RD search, DMMs and Region Boundary Chain mode have comparatively lower probability to be selected as best mode. This is because most of the CUs in depth map are flat or smooth, while DMMs and Region Boundary Chain mode are designed for CU with edge or sharp transition thus are less efficient for smooth CU compression.

# Proposed Solution

Based on this observation, we propose a method to early terminate the DMMs and Region Boundary Chain mode full-RD cost calculation with the following two conditions:

## Mode 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 likely to be flat or smooth. Therefore, we will add all the DMMs and Region Boundary Chain mode to full-RD cost calculations if the first mode in full-RD cost calculation list is not planar mode (uiRdModeList[0] != 0).

## Mode Selection based on the CU Variance

Another observation is that the variance of CUs selecting DMMs and Region Boundary Chain mode as best mode is often higher than that of CUs selecting intra prediction modes as best mode. Therefore, we will also add all the DMMs and Region Boundary Chain mode to full-RD cost calculations if the variance of current CU is higher than a threshold (varThreshold in Eqn. (2)), which is defined as

threshold = max((CU\_depth\_QP\*205)>>10)-4,1) (1)

varThreshold = threshold\*threshold-3\*(threshold-1) (2)

When CU\_depth\_QP is 34, 39, 42, 45, the corresponding variance threshold (varThreshold) are 1, 3, 7, 13.

Combining condition 2.1 and 2.2, the additional condition we check before adding DMMs and Region Boundary Chain mode to full-RD cost calculations is:

(first mode in full-RD cost calculation list is not planar mode) || (CU variance >= varThreshold) (3)

Considering existing conditions, we summarize our fast intra depth map mode selection algorithm in Figure 1.



Figure 1. Flow chart of proposed fast mode selection algorithm for intra depth map coding

# Experimental Results

The proposed method is implemented on HTM6.0 software.

In Table 1 we show the miss rate of proposed algorithm defined in Eqn. (4). Basically, miss rate means when our algorithm decides to skip DMM and Region Boundary Chain mode full-RD search for a certain block, the probability of that block chooses DMM or Region Boundary Chain mode as best prediction mode.

Miss\_rate= *P* (that block selects DMM or Region Boundary Chain mode as best prediction mode | our algorithm decides to skip DMM and Region Boundary Chain mode full-RD search for a certain block) (4)

As demonstrated in Table 1, the miss rate of proposed algorithm is very low.

Table 1. Miss rate of Proposed Algorithm

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | QP = 25\_34 | QP = 30\_39 | QP = 35\_42 | QP = 40\_45 |
| GTfly | 0.08% | 0.03% | 0.01% | 0.01% |
| Kendo | 0.03% | 0.02% | 0.01% | 0.00% |
| Newspaper | 0.18% | 0.09% | 0.03% | 0.00% |
| PoznanHall | 0.03% | 0.03% | 0.01% | 0.00% |
| Poznanstreet | 0.20% | 0.06% | 0.02% | 0.00% |
| Balloon | 0.05% | 0.03% | 0.01% | 0.00% |
| UndoDancer | 0.10% | 0.04% | 0.02% | 0.01% |
| **Average** | **0.10%** | **0.04**% | **0.02**% | **0.00**% |

Table 2 shows the coding performance of 3-view case under common test condition [2] for random access. No coding loss is observed and 0.1% gain in synthesized views is achieved. Table 3 shows the coding performance of 3-view case for all intra case. No coding loss is observed and 23.5% encoding time saving is achieved.

Table 2. BD rate results for 3-view case under CTC, Random Access



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



Table 4. Full RD Search Cycle Reduction

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | QP = 25\_34 | QP = 30\_39 | QP = 35\_42 | QP = 40\_45 | Average Saving  of each Sequence |
| GTfly | 30.94% | 25.28% | 27.09% | 29.43% | **28.18%** |
| Kendo | 16.14% | 15.67% | 18.11% | 23.62% | **18.38%** |
| Newspaper | 27.02% | 23.60% | 22.64% | 29.93% | **25.79%** |
| PoznanHall | 27.60% | 24.21% | 28.49% | 31.50% | **27.95%** |
| Poznanstreet | 25.99% | 27.16% | 23.45% | 26.47% | **25.76%** |
| Balloon | 19.01% | 19.13% | 21.87% | 26.71% | **21.68%** |
| UndoDancer | 29.46% | 28.32% | 27.42% | 28.37% | **28.39%** |
| **Average** | **25.16%** | **23.33%** | **24.15%** | **28.00** % | **25.16%** |

Beside run time saving, we further provide the Full-RD search cycle reduction (percentage of reduction of candidate modes for full-RD search) in Table 4. As observed, more than 25% Full RD search cycles are saved based on proposed algorithm.

# Conclusion

Fast mode selection algorithms of intra depth coding for 3D-HEVC is proposed. It is reported that for all intra test, the proposed algorithm achieves 23.5% encoding time saving without any bitrate loss. For random access case, 0.1% gain is achieved for synthesised views. It is suggested to inlcude the fast intra depth map mode selection method in HTM6.0.

# 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.

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[3] Jin Heo, Eunyong Son, Sehoon Yea, “Region boundary chain coding for depth-map”, JCT3V-A0070, 1st Meeting: Stockholm, SE, 16–20 July 2012.

# Patent rights declaration(s)

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