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| *Title:* | **CE6.H related: Results on modified deltaDC processing for DMM** | | |
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# Abstract

This contribution proposes a modified processing for the *deltaDC* method used with the DMM modes. Instead of operating with a QP-dependent quantization for the partition offset values, the proposed method omits the quantization and operates with full depth precision. At the encoder the optimum offset values are estimated by a VSO-based minimum distortion search. In order to obtain the coding gain for full depth precision without a considerable increase in encoder complexity, an optimized search algorithm is proposed. Furthermore, a fix for the initialization type of DMM contexts is provided. The contribution reports 0.2% coding gain for CTC and 0.7% for all-intra configuration.

# Introduction

The additional depth intra coding modes in 3DV-HTM, referred to as DMM, are adapted to the specific characteristics of depth maps by applying non-rectangular block partitions for approximating the signal of a depth block containing an edge. All four modes use a method for residual adaptation in the pixel domain, referred to as *deltaDC* method. This method consists of estimating the optimum offset to the predicted constant value for each of the two partitions of a DMM block by a VSO-based minimum distortion search. For reconstructing the signal of the block, these offset values are transmitted in the bit stream. The method currently used in 3D-HTM operates with a QP-dependent quantization of the offset values as illustrated in Fig. 1.

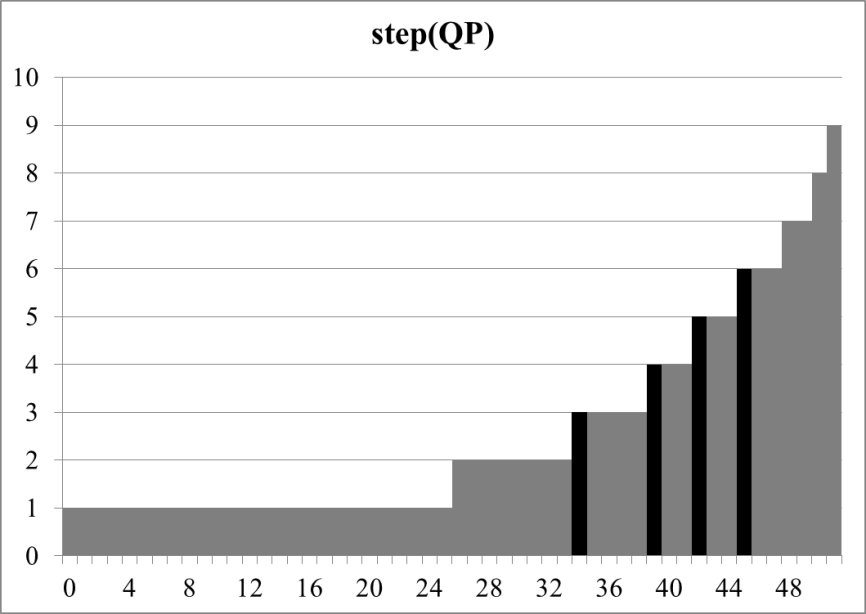


Figure 1: QP-dependent quantization step size used for DMM partition offset values in 3D-HTM.

We found that the quantization of the offset values limits the potential of the *deltaDC* approach with respect to residual adaptation. Therefore we propose to modify the *deltaDC* method for DMM modes by removing the quantization and operating with full depth precision, targeting a better coding performance without increasing the complexity.

# Proposed method

The proposed method is an alternative to the *deltaDC* method currently used for DMM modes and basically consists of the three parts presented in the following subsections.

## Un-quantized partition offset values

In the current 3D-HTM, partition offsets for DMM modes are transmitted as quantized values and consequently need to be de-quantized before being used for reconstructing the signal. The step size of the quantization depends on the luma QP value and is calculated as:

*Clip3( 1, ( 1 << BitDepthY ) − 1, Round( 2 (QP’Y /10)- 2 ) )*.

Inspired by the Simplified Depth Coding (SDC) method introduced in JCT3V-B0036, which also transmits partition offset values, but with full depth precision, i.e. not quantizing them, we propose to use un-quantized partition offset values also for DMM modes. Simply removing the quantization step from the current *deltaDC* scheme for DMM modes has the following effects: the residual adaptation becomes more precise, the absolute values that have to be signaled become larger, and the estimation at the encoder becomes more complex. This would result in about -0.1%/-0.2% BD-rate gain and an encoder runtime of about 102%/125% for random access (CTC)/all-intra configuration.

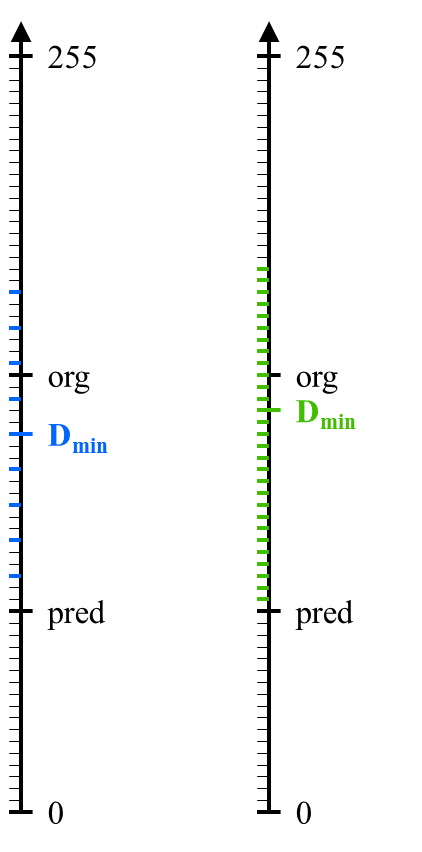


Figure 2: Partition offset estimation with and without quantization.

## Optimized search strategy

The motivation for modifying the search strategy for offset estimation in DMM modes of the current *deltaDC* scheme is to obtain the coding gain of using un-quantized partition offset values without suffering from the considerable increase in encoder complexity.

The optimized search strategy basically consists of a coarse search and a refinement step. In more detail the search now works as follows: Initially the distortion of using the partition values that are calculated as the mean value of the original sample values covered by the corresponding region is determined. In JCT3V-B0036 the offset between these values and the predicted partition values is simply transmitted without a VSO-based minimum distortion search. For DMM modes the search tests all combinations of offset values in a certain range around the predicted and original partition values. In contrast to the current method we have slightly modified the limits of the search range, now starting from an offset value of 0 instead of 1 and restricting the upper limit if it would exceed the actual range of depth values. Now, the coarse search is carried out, testing offset values at intervals of 4. For each tested combination of offset values the distortion is compared to the initial distortion achieved with the original partition values. Only if at least one of the coarse offset combinations leads to a smaller distortion than the original partition values, the refinement step is carried out for the best coarse combination. The refinement step simply consists of testing all offsets in the range of [-3, 3] around the best coarse offset combination.

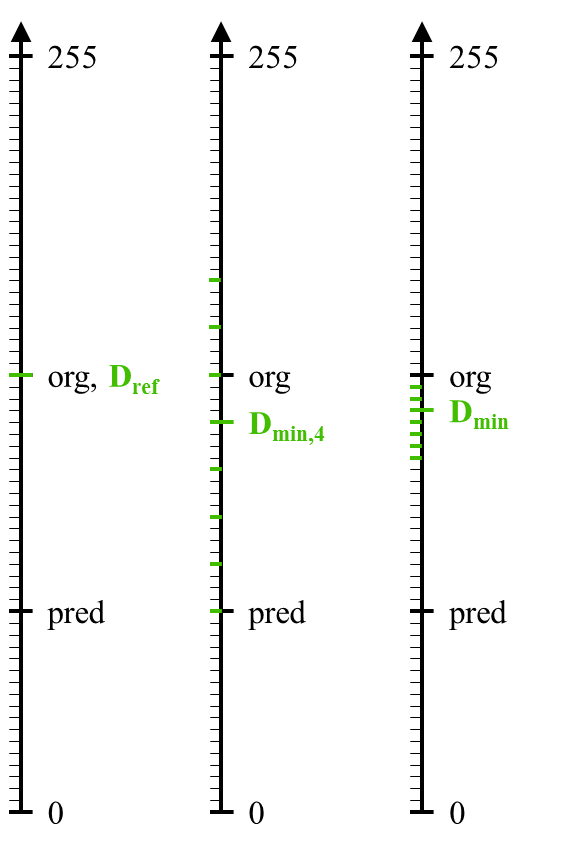


Figure 3: Optimized search strategy with un-quantized partition offset values.

## Fix for DMM context initialization

It was found that the data type for context initialization values has changed from Short to UChar since the DMM modes were first implemented. This is fixed by setting the data type for the DMM contexts to UChar, which results in a very small coding gain.

# Experimental results

According to the CE6 description in JCT3V-B1106 [1] and the common test conditions in JCT3V-B1100 [2], the proposed method is evaluated for *random access* (CTC) and *all‑intra* configuration.

**Table 1. Result for 3-view scenario under CTC**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **video only** | **synthesized only** | **coded & synthesized** | **enc time** | **dec time** | **ren time** |
| Balloons | 0.0% | -0.1% | 0.0% | 100.6% | 91.6% | 99.4% |
| Kendo | 0.0% | -0.1% | 0.0% | 100.2% | 95.0% | 99.6% |
| Newspapercc | 0.0% | -0.3% | -0.2% | 100.5% | 96.0% | 100.5% |
| GhostTownFly | 0.0% | -0.3% | -0.2% | 100.8% | 99.4% | 96.8% |
| PoznanHall2 | 0.0% | -0.1% | -0.1% | 99.9% | 87.3% | 96.2% |
| PoznanStreet | 0.0% | -0.2% | -0.1% | 100.3% | 94.1% | 99.1% |
| UndoDancer | 0.0% | -0.1% | -0.1% | 100.2% | 95.0% | 99.3% |
| 1024x768 | 0.0% | -0.1% | -0.1% | 100.4% | 94.2% | 99.8% |
| 1920x1088 | 0.0% | -0.2% | -0.1% | 100.3% | 93.9% | 97.8% |
| **average** | **0.0%** | **-0.2%** | **-0.1%** | **100.3%** | **94.0%** | **98.7%** |

**Table 2. Result for 3-view scenario under all-intra configuration**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **video only** | **synthesized only** | **coded & synthesized** | **enc time** | **dec time** | **ren time** |
| Balloons | 0.0% | -0.4% | -0.2% | 107.0% | 91.8% | 99.1% |
| Kendo | 0.0% | -0.4% | -0.2% | 107.1% | 99.6% | 100.2% |
| Newspapercc | 0.0% | -0.8% | -0.4% | 107.0% | 95.7% | 99.9% |
| GhostTownFly | 0.0% | -1.1% | -0.7% | 108.1% | 102.8% | 98.1% |
| PoznanHall2 | 0.0% | -0.7% | -0.5% | 104.1% | 107.8% | 100.3% |
| PoznanStreet | 0.0% | -0.5% | -0.3% | 106.1% | 99.3% | 99.8% |
| UndoDancer | 0.0% | -0.9% | -0.6% | 104.7% | 98.6% | 101.0% |
| 1024x768 | 0.0% | -0.5% | -0.3% | 107.1% | 95.7% | 99.7% |
| 1920x1088 | 0.0% | -0.8% | -0.5% | 105.7% | 102.1% | 99.8% |
| **average** | **0.0%** | **-0.7%** | **-0.4%** | **106.3%** | **99.3%** | **99.8%** |

# Draft specification

The proposed method, more precisely the part described in section 2.1, requires the following change to the specification in Annex G, section G.8.4.4.2.12 of JCT3V-B1005 [3]:

…

For X being replaced by 0 and 1, the values of the prediction samples predSamples[ x ][ y ] are derived as specified by the following ordered steps:

* 1. The variable sumNeigh specifying the sum of the neighbouring samples depth values of partition X is set equal to 0 and the variable numNeigh specifying the number of the neighbouring samples of partition X is set equal to 0 and the following applies.
     + For x = 0..nT − 1 the following applies.
       - When partitionPattern[ x ][ 0 ] is equal to X, the following applies:

sumNeigh += p[ x ][ −1 ] (G‑59)  
numNeigh += 1 (G‑60)

* + - For y = 0..nT − 1 the following applies.
      * When partitionPattern[ 0, y ] is equal to X, the following applies:

sumNeigh += p[ −1 ][ y ] (G‑61)   
numNeigh += 1 (G‑62)

* 1. The variables predDcVal specifying the predicted constant partition values for partition X is derived as follows.
     + 1. predDcVal = ( numNeigh ! = 0 ) ? ( sumNeigh / numNeigh ) : ( 1 << ( BitDepthY − 1 ) ) (G‑63)
  2. ~~The variable deQuantDcOffset specifying the de-quantized DC offset is derived as follows.~~
     + ~~If dcOffsetAvailFlag is equal to 1, the following applies. :~~
       - 1. ~~dcOffset =~~  ~~quantDcOffsetPX \* Clip3( 1, ( 1 << BitDepth~~~~Y~~ ~~) − 1, Round( 2~~ ~~(QP’~~~~Y~~ ~~/10)- 2~~ ~~) )~~ (G‑64)
     + ~~Otherwise ( dcOffsetAvailFlag is equal to 0), deQuantDcOffset is set equal to 0.~~

~~4.~~3. The predicted sample values predSamples are derived as follows for x = 0..nT−1 and for y = 0..nT−1.

* + - When partitionPattern[ x ][ y ] is equal to X, the following applies.
      * If dcOffsetAvailFlag is equal to 1, the following applies:
        1. predSamples[ x ][ y ] = predDcVal + ~~dcOffset~~quantDcOffsetPX
      * Otherwise (dcOffsetAvailFlag is equal to 0), the following applies:
        1. predSamples[ x ][ y ] = predDcVal

…

For logical reasons “quantDcOffsetP0/1/X” should then be renamed to “dcOffsetP0/1/X”.

# Conclusion

The results show that the proposed method achieves a BD-rate reduction of 0.2% for CTC and 0.7% for all-intra configuration. Furthermore, the decoder complexity is not affected, while the encoder complexity increases slightly. The changes to the draft text are very small, simplifying the specification of the *deltaDC* prediction process. In conclusion, the proposed modifications lead to a better coding performance and simplify the decoding process for the DMM modes and should therefore be considered for adoption to 3DV-HTM.

# References

1. P. Merkle, "Description of Core Experiment 6 (CE6) on Depth Intra Coding", JCT3V-B1106, Shanghai, China, October 2012.
2. D. Rusanovskyy, K. Müller, A. Vetro, "Common Test Conditions of 3DV Core Experiments", JCT3V-B1100, Shanghai, China, October 2012.
3. G. Tech, K. Wegner, Y. Chen, S. Yea, “3D-HEVC Test Model 2,” JCT3V-B1005, Shanghai, China, October 2012.

# Patent rights declaration

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