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| *Title:* | **CE5.h related : Bug Fix and Extension of Illumination Compensation** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution reports results of bug-fix of illumination compensation in the latest HTM version. There are two bugs in current implementation: first, there is one minor inconsistency between the working draft and software for chroma component, second, illumination compensation maybe switched off for some inter modes unintentionally at encoder. Meanwhile, we also apply illumination compensation method to depth coding to compensate discrepancy between different depth views.

It is reported that by fixing the first bug, there is 0.0% performance change, and by fixing the second (encoder only) bug, there is -0.3%, -0.2% and -0.1% gain on two side views, video and coded and synthesized view respectively. The best performance is achieved on kendo, with -1.0% and -0.9% gain on two side views and -0.5%, -0.3% and -0.3% gains on video, synthesized view, and coded and synthesized view respectively. By applying illumination compensation method to depth coding, there is another -0.2% gain on synthesized view and -0.1% gain on coded and synthesized view, with at most -0.5% gain on synthesized view and -0.4% gain on coded and synthesized view for newspaper.

# Bug Fix

In the implementation of illumination compensation in HTM, there are two bugs.

First, for chroma, there is one inconsistency between working draft and software. In the working draft,

– For X from 0 to 1, inclusive, if the value of predFlagLX is equal to 1, the following processes steps apply in order.

1. Derive the top-left sample of the reference block of the reference picture indetified in RefPicListX.

xRX = xC + ( mvLX[ 0 ] >> (2 + (cIdx ? 1 : 0)) ), (G‑127)

yRX = yC + ( mvLX[ 1 ] >> (2 + (cIdx ? 1 : 0)) ), (G‑127)

However, in the software, for chroma component, xRX, yRX are calculated as:

xRX = xC + ( mvLX[ 0 ] >> (2 + (cIdx ? 2 : 0)) ), (G‑127)

yRX = yC + ( mvLX[ 1 ] >> (2 + (cIdx ? 2 : 0)) ), (G‑127)

Second, at encoder, illumination compensation maybe disabled for all inter modes except Merge and Size\_NxN because illumination compensation flag is not reset before these modes. This is an encoder-only bug.

# Illumination Compensation in Depth Coding

We also apply illumination compensation [1] used in texture coding to depth coding to compensate discrepancy between different depth views.

Same illumination model and parameter training methods are used. Parameters in IC model are estimated for each PU (prediction unit) using available reconstructed neighbouring pixels and therefore are not need to be encoded. Applying illumination compensation or not is decided at CU (coding unit) level, and an illumination compensation flag is coded for CU where inter-view prediction is used. Also, whether there is illumination discrepancy is decided at picture level at encoder, and an illumination compensation flag is encoded for the first slice of each picture in dependent depth views.

# Results

Proposed method is integrated into 3DV-HTM 5.0.1 software and compared with it. Three experiment sets are tested following the configuration and common test condition defined in [2].

1. Set 1: fix the first bug
2. Set 2: fix the second bug
3. Set 3: set 2 + apply illumination compensation method to depth coding

## Performance after fixing the first bug

As shown in Table 1, there is negligible influence on compression performance as well as encoding/decoding time.

Table 1: performance comparison with HTM-5.0.1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 97.5% | 100.1% |
| Kendo | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.9% | 99.9% |
| Newspapercc | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.2% | 100.1% |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 98.7% | 100.3% |
| PoznanHall2 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 99.0% | 99.7% |
| PoznanStreet | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 98.9% | 100.2% |
| UndoDancer | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 95.1% | 98.7% |
| 1024x768 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 99.6% | 100.0% |
| 1920x1088 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 97.9% | 99.7% |
| **average** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **98.6%** | **99.9%** |

## Performance after fixing the second bug

As shown in Table 2, by fixing the second bug, there is -0.3% gain on two side views and -0.1% gain on coded and synthesized view, while the encoding/decoding time are not changed much

Table 2: performance comparison with HTM-5.0.1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | -0.4% | -0.3% | -0.2% | 0.0% | -0.1% | 101.8% | 100.0% |
| Kendo | 0.0% | -1.0% | -0.9% | -0.5% | -0.3% | -0.3% | 101.4% | 99.8% |
| Newspapercc | 0.0% | -0.5% | -0.6% | -0.2% | -0.2% | -0.2% | 101.0% | 99.9% |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 97.9% | 100.2% |
| PoznanHall2 | 0.0% | -0.1% | -0.2% | -0.1% | 0.1% | 0.0% | 101.4% | 99.9% |
| PoznanStreet | 0.0% | -0.2% | -0.2% | -0.1% | -0.1% | -0.1% | 104.5% | 99.9% |
| UndoDancer | 0.0% | -0.1% | 0.0% | 0.0% | -0.1% | -0.1% | 98.0% | 98.5% |
| 1024x768 | 0.0% | -0.6% | -0.6% | -0.3% | -0.2% | -0.2% | 101.4% | 99.9% |
| 1920x1088 | 0.0% | -0.1% | -0.1% | -0.1% | 0.0% | 0.0% | 100.4% | 99.6% |
| **average** | **0.0%** | **-0.3%** | **-0.3%** | **-0.2%** | **-0.1%** | **-0.1%** | **100.8%** | **99.8%** |

## Performance after fixing the second bug and applying illumination compensation method to depth coding

As shown in Table 3, by fixing the second bug and also applying illumination compensation method to depth coding, there is -0.3% and -0.2% gain on synthesized view and coded and synthesized view respectively. The encoding time is increased by 2.8% and the decoding is not changed much. The gain brought by applying illumination compensation to depth coding is also shown in Table 4, there is -0.2% and -0.1% gain on synthesized view and coded and synthesized view respectively. The encoding time is increased by 1.9% and the decoding time is not changed much.

Table 3: performance comparison with HTM-5.0.1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | -0.4% | -0.3% | -0.2% | -0.2% | -0.1% | 103.9% | 100.2% |
| Kendo | 0.0% | -1.0% | -0.9% | -0.5% | -0.4% | -0.4% | 103.4% | 100.3% |
| Newspapercc | 0.0% | -0.5% | -0.6% | -0.2% | -0.5% | -0.5% | 103.5% | 100.5% |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | 101.2% | 100.2% |
| PoznanHall2 | 0.0% | -0.1% | -0.2% | -0.1% | -0.2% | -0.1% | 102.7% | 100.3% |
| PoznanStreet | 0.0% | -0.2% | -0.2% | -0.1% | -0.4% | -0.2% | 102.7% | 100.2% |
| UndoDancer | 0.0% | -0.1% | 0.0% | 0.0% | -0.1% | -0.1% | 101.9% | 98.6% |
| 1024x768 | 0.0% | -0.6% | -0.6% | -0.3% | -0.4% | -0.3% | 103.6% | 100.3% |
| 1920x1088 | 0.0% | -0.1% | -0.1% | -0.1% | -0.2% | -0.1% | 102.1% | 99.8% |
| **average** | **0.0%** | **-0.3%** | **-0.3%** | **-0.2%** | **-0.3%** | **-0.2%** | **102.8%** | **100.0%** |

Table 4: performance comparison with set2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | -0.1% | 102.1% | 100.2% |
| Kendo | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | 102.0% | 100.5% |
| Newspapercc | 0.0% | 0.0% | 0.0% | 0.0% | -0.4% | -0.3% | 102.5% | 100.5% |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | 103.4% | 100.0% |
| PoznanHall2 | 0.0% | 0.0% | 0.0% | 0.0% | -0.2% | -0.1% | 101.2% | 100.4% |
| PoznanStreet | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | -0.2% | 98.2% | 100.2% |
| UndoDancer | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 104.0% | 100.1% |
| 1024x768 | 0.0% | 0.0% | 0.0% | 0.0% | -0.2% | -0.1% | 102.2% | 100.4% |
| 1920x1088 | 0.0% | 0.0% | 0.0% | 0.0% | -0.2% | -0.1% | 101.7% | 100.2% |
| **average** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **-0.2%** | **-0.1%** | **101.9%** | **100.3%** |

# Reference

[1] H. Liu, J. Jiwook, J. Sung, *etc.*, “3D-CE2.h: Results of Illumination Compensation for Inter-View Prediction”, Doc. JCT3V-B0045, Shanghai, CN, 13–19 Oct. 2012.

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

# Patent rights declaration(s)

**LG Electronics / LG Electronics (China) R&D Center may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**

Working draft

|  |  |
| --- | --- |
| if( ( weighted\_pred\_flag && slice\_type = = P) | |  ( weighted\_bipred\_flag && slice\_type = = B ) ) |  |
| pred\_weight\_table( ) |  |
| else if ( layer\_id ~~&& !DepthFlag~~) |  |
| **slice\_ic\_enable\_flag** | u(1) |
| **five\_minus\_max\_num\_merge\_cand** | ue(v) |

If DepthFlag is equal to 0.

The variable anyIvRefPicFlag is initially set equal to 0. When PredMode[ x0 ][ y0 ] is not equal to MODE\_INTRA the following applies for X being replaced by 0 and 1, and Y being equal to 1−X.

* 1. anyIvRefPicFlag = anyIvRefPicFlag | |    
     (inter\_pred\_idc[ x0 ][ y0 ] ! = Pred\_LY && refViewIdxLX[ x0 ][ y0 ] ! = ViewIdx)  | |    
     (inter\_pred\_idc[ x0 ][ y1 ] ! = Pred\_LY && refViewIdxLX[ x0 ][ y1 ] ! = ViewIdx)  | |   
     (inter\_pred\_idc[ x1 ][ y0 ] ! = Pred\_LY && refViewIdxLX[ x1 ][ y0 ] ! = ViewIdx)  | |    
     (inter\_pred\_idc[ x1 ][ y1 ] ! = Pred\_LY && refViewIdxLX[ x1 ][ y1 ] ! = ViewIdx)   (G‑)

else, If DepthFlag is equal to 1.

The variable anyIvRefPicFlag is initially set equal to 0. When PredMode[ x0 ][ y0 ] is not equal to MODE\_INTRA the following applies for X being replaced by 0 and 1, and Y being equal to 1−X.

minTrafoSize = 1 << Log2MinTrafoSize;

nCbSize = 1 << log2CbSize;

for ( i = 0; i < nCbSize; i += minTrafoSize ) {

for ( j = 0; j < nCbSize; j += minTrafoSize ) {

anyIvRefPicFlag = anyIvRefPicFlag | |    
(inter\_pred\_idc[ x0+i ][ y0+j ] ! = Pred\_LY && refViewIdxLX[ x0+i ][ y0+j ] ! = ViewIdx) (G‑)

}

}