|  |  |
| --- | --- |
| **Joint Collaborative Team on 3D Video Coding Extension Development**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  3rd Meeting: Geneva, CH, 17–23 Jan. 2013 | Document: JCT3V-C0111 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Non-CE Simplification of illumination compensation** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Jiwook Jung Hongbin Liu Jie Jia Sehoon Yea | Tel: Email: | +82-2-6912-6477 jiwook.jung@lge.com |
| *Source:* | LG Electronics | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

In the last meeting, Illumination Compensation(IC) was adopted for improving performance of inter-view prediction. It had significant benefits for correction of luminance/chrominance mismatch between views. However, the method had relatively high complexity. To solve least square solution, multiplications between arbitrary sample values were necessary. In this proposal, simplification of IC is presented. Using only offset model, IC can be carried out by multiplication-free process. It has BD-rate coding change 0.0% compared to current IC model on video only result with xx% encoding time, and xx% decoding time. Compared to disabling IC on HTM-5.0.1, coding gain -0.3% is maintained on video only.

# Introduction

In JCV3V-B0045[1], linear model compensation was applied to correct inter-view luminance / chrominance mismatches. When the IC flag on CU was turned on, each pixel on disparity compensated block were compensated the below equations.

Where, is compensated prediction samples in a block and is prediction samples in a block before compensation is applied. Parameter can be derived from reconstructed samples around ,.

Both encoder and decoder should solve the linear least square equations to estimate . The below equations presents the linear least square solution. To reduce computing complexity, the division was replaced by multiplication, shift, and look-up-table. But, It has still multiplications of arbitrary sample values for computing cross-correlation of samples.

Where, , are left and top neighbor pixels by ,, respectively.

# Proposed Method

For the complexity reduction of current IC, Only offset model is applied to compensate luminance/chrominance mismatches. IC can be carried out using only additions and shifts without multiplications. The compensation model is just adding an offset as the below equation.

The parameter can be calculated by the below equation.

There is some coding loss on the average with respect to reduce the estimation order. However, It has the advantage removing multiplications of arbitrary numbers on IC process.

# Complexity Analysis

Table1. comparison of operation number of current and proposed IC (per pixel)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Prediction step | Current IC | | | Proposed IC | | |
| Mul | Add | Shift | Mul | Add | Shift |
| Calculation of and for one block | ~=3·*N* +6 | ~=6·*N* +4 | ~=6 | 0 | ~=3·*N* +1 | ~=1 |
| Prediction for each pixel | 1 | 1 | 1 | 0 | 1 | 1 |
| Total operation number for each pixel prediction | 1+3/ *N +*6/ *N2* | 1+6/ *N +4*/ *N2* | 1+6/ *N2* | 0 | 1+3/ *N +*1/ *N2* | 1+1/*N2* |

Table2. comparison of operation number of current and proposed IC (16x16 block example )

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Prediction step | Current IC | | | Proposed IC | | |
| Mul | Add | Shift | Mul | Add | Shift |
| Calculation of and for 16x16 block | ~=54 | ~=100 | ~=6 | 0 | ~=49 | ~=1 |
| Prediction for each pixel | 1 | 1 | 1 | 0 | 1 | 1 |
| Total operation number for a 16x16 block | 55 | 101 | 7 | 0 | 50 | 2 |

# Experimental results

Table1 and Table2 reportedly shows the experimental results. In this contribution, the bug fix on JCT3V-C0046[2] is also applied.

Table1. BD-rate changes of proposed method with IC\_bugfix, Anchor : HTM-5.0.1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | -1.1% | -0.7% | -0.4% | -0.2% | -0.3% | 102.0% | 102.8% |
| Kendo | 0.0% | 0.4% | 0.2% | 0.1% | 0.2% | 0.2% | 101.3% | 96.0% |
| Newspapercc | 0.0% | -0.5% | -0.4% | -0.2% | -0.1% | -0.1% | 100.8% | 100.5% |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.1% | 92.5% |
| PoznanHall2 | 0.0% | -0.3% | -1.9% | -0.6% | -0.3% | -0.3% | 100.8% | 95.6% |
| PoznanStreet | 0.0% | -0.5% | -0.3% | -0.1% | -0.1% | -0.1% | 100.3% | 102.2% |
| UndoDancer | 0.0% | 0.1% | 0.0% | 0.0% | -0.1% | -0.1% | 100.2% | 101.6% |
| 1024x768 | 0.0% | -0.4% | -0.3% | -0.2% | 0.0% | -0.1% | 101.4% | 99.7% |
| 1920x1088 | 0.0% | -0.2% | -0.6% | -0.2% | -0.1% | -0.1% | 100.4% | 97.9% |
| **average** | **0.0%** | **-0.3%** | **-0.5%** | **-0.2%** | **-0.1%** | **-0.1%** | **100.8%** | **98.7%** |

Table2. BD-rate change of proposed method, Anchor : JCT3V-C0046[2] (bug fix)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | -0.8% | -0.4% | -0.2% | -0.1% | -0.1% |  |  |
| Kendo | 0.0% | 1.5% | 1.2% | 0.6% | 0.7% | 0.6% |  |  |
| Newspapercc | 0.0% | 0.0% | 0.1% | 0.0% | 0.2% | 0.2% |  |  |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% |  |  |
| PoznanHall2 | 0.0% | -0.3% | -1.7% | -0.5% | -0.3% | -0.3% |  |  |
| PoznanStreet | 0.0% | -0.3% | -0.1% | -0.1% | 0.2% | 0.1% |  |  |
| UndoDancer | 0.0% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% |  |  |
| 1024x768 | 0.0% | 0.2% | 0.3% | 0.1% | 0.3% | 0.3% |  |  |
| 1920x1088 | 0.0% | -0.1% | -0.4% | -0.1% | 0.0% | 0.0% |  |  |
| **average** | **0.0%** | **0.1%** | **-0.1%** | **0.0%** | **0.1%** | **0.1%** |  |  |

Table3. BD-rate change of offset model, Anchor : HTM-5.0.1, (IlluCompEnable : 0)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video only | synthesized only | coded & synthesized | enc time | dec time |
| Balloons | 0.0% | -2.6% | -2.3% | -1.1% | -0.7% | -0.8% | 108.5% | 94.3% |
| Kendo | 0.0% | -2.9% | -4.2% | -1.6% | -1.2% | -1.3% | 109.6% | 98.2% |
| Newspapercc | 0.0% | -1.1% | -1.4% | -0.6% | -0.5% | -0.5% | 105.7% | 100.5% |
| GhostTownFly | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 100.8% | 99.9% |
| PoznanHall2 | 0.0% | -0.5% | -3.2% | -0.9% | -0.5% | -0.6% | 105.6% | 106.0% |
| PoznanStreet | 0.0% | 0.1% | -0.4% | -0.1% | -0.1% | -0.1% | 104.7% | 106.2% |
| UndoDancer | 0.0% | 0.2% | 0.2% | 0.1% | 0.1% | 0.1% | 103.9% | 98.6% |
| 1024x768 | 0.0% | -2.2% | -2.7% | -1.1% | -0.8% | -0.9% | 107.9% | 97.7% |
| 1920x1088 | 0.0% | -0.1% | -0.8% | -0.2% | -0.1% | -0.2% | 103.7% | 102.6% |
| **average** | **0.0%** | **-1.0%** | **-1.6%** | **-0.6%** | **-0.4%** | **-0.5%** | **105.5%** | **100.5%** |

# WD Text

# Conclusion

It is recommended that proposed method is adopted into 3DV-HEVC.

# Reference

1. H. Liu, J. Jung, J. Sung*, etc.*, (LG), "3D-CE2.h : Results of Illumination Compensation for Inter-View Prediction", Joint Collaborative Team on 3D Video Coding Extension Development (JCT-3V) of ITU-T VCEG and ISO/IEC MPEG JCT3V-B0045, Shanghai, China, October, 2012.
2. H. Liu, J. Jung, J. Sung*, etc.*, (LG), "CE5.h related : Bug Fix and Extension of Illumination Compensation", Joint Collaborative Team on 3D Video Coding Extension Development (JCT-3V) of ITU-T VCEG and ISO/IEC MPEG JCT3V-C0046, Geneva, Switzerland, October, 2012.

# Patent rights declaration(s)

**LG electronics 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).**