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| **Joint Collaborative Team on 3D Video Coding Extensions**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  8th Meeting: Valencia, ES, 29 March – 4 April 2014 | Document: JCT3V-H0063\_r1 |  |  |

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| *Title:* | **CE2: Results of ARP simplification** | | |
| *Status:* | Input Document to JCT-3V | | |
| *Purpose:* | Proposal | | |
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# Abstract

This proposal reports a CE result of omitting residual prediction for 4x4 chroma block to reduce the worst case memory bandwidth complexity. The experiment result shows that the BD-rate loss is 0.1 %, 0.1 % and 0.1 % in video, total video and synthesis respectively.

Revision 1 added complexity analisys results in 4x2 and 8x4 memory pattern.

# Introduction

JCT3V-H0033 has reported that ARP’s worst case memory bandwidth is more than 122 % compared with HEVC version1 worst case and proposed to omit residual prediction for 4x4 chroma block. The proposal was tested in CE2 activity.

# Proposal

The text of the proposal of omiting chroma residual prediction for 4x4 chroma block was highlighted in yellow.

* If nPbW is greater than 8, the modified prediction samples predSamplesLXCb[ x ][ y ] with x = 0..( nPbW /2 ) − 1 and y = 0..( nPbH /2 )−1 are derived as specified in the following:
  1. predSamplesLXCb[ x ][ y ] = predSamplesLXCb[ x ][ y ] +   
      ( ( rpSamplesLXCb[ x ][ y ] − rpRefSamplesLXCb[ x ][ y ] )  >>  shiftVal ) (I‑227)
* If nPbW is greater than 8, the modified prediction samples predSamplesLXCr[ x ][ y ] with x = 0..( nPbW /2 ) − 1 and y = 0..( nPbH /2 ) − 1 are derived as specified in the following:
  1. predSamplesLXCr[ x ][ y ] = predSamplesLXCr[ x ][ y ] +   
      ( ( rpSamplesLXCr[ x ][ y ] − rpRefamplesLXCr[ x ][ y ] )  >>  shiftVal ) (I‑228)

# Simulation results

Experimental result based on HTM10 is shown in Table 1.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | video 0 | video 1 | video 2 | video PSNR / video bitrate | video PSNR / total bitrate | synth PSNR / total bitrate | enc time | dec time | ren time |
| Balloons | 0.0% | 1.0% | 1.0% | 0.30% | 0.26% | 0.28% | 100.2% | 99.5% | 100.8% |
| Kendo | 0.0% | 0.6% | 0.5% | 0.16% | 0.11% | 0.22% | 100.1% | 103.5% | 100.4% |
| Newspaper\_CC | 0.0% | 0.3% | 0.2% | 0.11% | 0.11% | 0.11% | 100.2% | 101.8% | 101.4% |
| GT\_Fly | 0.0% | 0.1% | 0.1% | 0.00% | -0.01% | 0.00% | 100.0% | 100.6% | 100.3% |
| Poznan\_Hall2 | 0.0% | 0.1% | 0.0% | 0.03% | 0.01% | -0.05% | 100.1% | 100.6% | 100.5% |
| Poznan\_Street | 0.0% | 0.0% | 0.2% | 0.03% | 0.03% | 0.02% | 99.7% | 99.5% | 99.6% |
| Undo\_Dancer | 0.0% | 0.1% | 0.1% | 0.01% | 0.01% | 0.00% | 99.6% | 102.6% | 100.0% |
| Shark | 0.0% | 0.4% | 0.4% | 0.05% | 0.02% | 0.04% | 100.1% | 100.5% | 99.9% |
| 1024x768 | 0.0% | 0.7% | 0.6% | 0.19% | 0.16% | 0.20% | 100.2% | 101.6% | 100.9% |
| 1920x1088 | 0.0% | 0.2% | 0.2% | 0.02% | 0.01% | 0.00% | 99.9% | 100.8% | 100.0% |
| **average** | **0.0%** | **0.4%** | **0.3%** | **0.08%** | **0.07%** | **0.08%** | **100.0%** | **101.1%** | **100.4%** |

# Complexity comparison

Table 2 shows that worst case complexity comparison in terms of number of operations and memory bandwidth.

Table 2: Complexity comparison between anchor and proposal

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| anchor (3D-HEVC ARP) | CU | PU | Mult | Add | Bandwidth | Mult [%] | Add [%] | Bandwidth [%] |
| 64x64 | 64x64 | 36.4 | 24.2 | 9.4 | 64% | 50% | 93% |
| 32x32 | 32x32 | 36.8 | 24.4 | 9.8 | 64% | 50% | 97% |
| 16x16 | 16x16 | 37.5 | 24.8 | 10.6 | 66% | 51% | 105% |
| 8x8 | 8x8 | 39.0 | 25.5 | 12.3 | 68% | 53% | 122% |
| proposal (3D-HEVC ARP) | CU | PU | Mult | Add | Bandwidth | Mult [%] | Add [%] | Bandwidth [%] |
| 64x64 | 64x64 | 36.4 | 24.2 | 9.4 | 64% | 50% | 93% |
| 32x32 | 32x32 | 36.8 | 24.4 | 9.8 | 64% | 50% | 97% |
| 16x16 | 16x16 | 37.5 | 24.8 | 10.6 | 66% | 51% | 105% |
| 8x8 | 8x8 | 25.5 | 15.8 | 7.6 | 45% | 32% | 75% |

Table 3 shows that worst case complexity comparison in 4x2 and 8x2 pattern with fixed SHVC complexity analisys sheet.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Memory pattern | | |
|  | 1x1 | 4x2 | 8x2 |
| HTM10 | 122% | 135% | 158% |
| H0132 (mod bi pred) | 101% | 113% | 132% |
| H0063 (chroma4x4) | 105% | 95% | 117% |
| H0132+H0063 | 83% | 87% | 117% |

It is asserted that chroma 4x4 removal remains highly required when considering more actual data access pattern.

# Conclusion

This proposal omits residual prediction for 4x4 chroma block. Because the proposal addresses the worst case concerns with small impact, it is recommended to adopt this method in 3D-HEVC.

# Patent rights declaration

**Sharp Corporation 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).**

# References

[1] T. Ikai, “CE4-related: ARP simplification”, JCT3V-H0033, JCT-3V 7th Meeting: San Jose, USA, 11 Jan. – 17 Jan. 2013