|  |  |
| --- | --- |
| **Joint Collaborative Team on 3D Video Coding Extensions**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  10th Meeting: Strasbourg, FR, 18–24 Oct. 2014 | Document: JCT3V-J0022 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Syntax cleanup of depth dc offset** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Takeshi Tsukuba  Tomohiro Ikai  1-9-2 Nakase, Mihama-ku, Chiba-shi, Chiba 261-8520, JAPAN | Tel: Email: | +81-43-299-8526 [tsukuba.takeshi@sharp.co.jp](mailto:tsukuba.takeshi@sharp.co.jp) |
| *Source:* | SHARP Corporation | | |

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

# Abstract

This contribution proposes to clean up dc offset related syntax element by removing depth\_dc\_flag with a context model adjustment. Experimental result reportedly shows -0.02% and -0.04% bdrate changes for synthesis in the CTC and all-intra configuration, respectively. It is asserted that this proposed method can remove a syntax element and simplify dc offset decoding process with no coding loss.

# Introduction

In the current 3D-HEVC [1], the dc offset (DcOffset) is signalled by three syntax elements, depth\_dc\_flag, depth\_dc\_abs and depth\_dc\_sign\_flag. The DcOffset is derived differently depending on dcNumSeg as follows:

DcOffset = (depth\_dc\_flag == 0) ? 0 : (depth\_dc\_abs + 1) \* sign (if dcNumSeg = 1)

DcOffset = (depth\_dc\_flag == 0) ? 0 : depth\_dc\_abs \* sign (if dcNumSeg = 2)

It can be understandable that the depth\_dc\_flag has been introduced aiming to signal zero DcOffset value case more efficiently in the case that both dc offset are equal to zero. At the same time, it makes us to endure more complex syntax. Besides it also requires a syntax inference rule and complex rate cost calculations in encoder sides.

# Proposed Method

This contribution proposes two changes in signaling dc offset as follows:

1. Remove a syntax element depth\_dc\_flag and modify handling a offset value of depth\_dc\_abs
2. Adjust context model for depth\_dc\_abs

Table 1 summarise the difference between HTM12 and proposal

Table : the difference between HTM12 and proposal

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Intra/Inter | SDC | Angular/DMM | 2Nx2N/NxN  \*2 | dcNumSeg in PU | HTM-12 | | Proposal | |
| depth\_dc\_flag | offset \*1 | depth\_dc\_flag | offset \*1 |
| Intra | 0 | DMM | 2Nx2N | 2 | infer to be 1 | 0 | removed | 0 |
| Intra | 0 | DMM | NxN | 2 | infer to be 1 | 0 | 0 |
| Intra | 1 | Angular | 2Nx2N | 1 | yes | 1 | 0 |
| Intra | 1 | DMM | 2Nx2N | 2 | yes | 0 | 0 |
| Inter | 1 | - | 2Nx2N | 1 | infer to be 1 | 1 | 1 |

\*1: offset means the starting value of Abs( DcOffset[] )

\*2: In the case of NxN, SDC is prohibited.

In most cases, the proposal is equivalent to HTM12. For example, in DMM (without IntraSDC) and InterSDC of HTM12, which doesn’t send depth\_dc\_flag (inferred to be 1) and send depth\_dc\_abs with offset value of 0 or 1, it is equivalent that no depth\_dc\_flag case in our proposal. The difference is in DMM and Angular (with IntraSDC) case where HTM12 can send the case with both DcOffsets being zero with depth\_dc\_flag. However again, we do not confirm the benefit because it is found that there is no significant loss by removing the syntax element.

**Syntax element versus context model**

In our proposal, the context increment for prefix of depth\_dc\_abs (binIdx=0..2) is derived as follows:

ctxInc = (sdc\_flag && CuPredMode == MODE\_INTRA)

Although there can be arguable that introducing context model may nullify the simplification of removing syntax element, we are confident that it is a simplification. Comparing context model and syntax element of depth\_dc\_abs, our approach has the following benefits.

* Simpler syntax structure, smaller number of conditions and no inference rule
* Easier rate cost calculation in encoder side

# Text changes

I.7.3.8.5.2 Coding unit extension syntax

|  |  |
| --- | --- |
| cu\_extension( x0 , y0 , log2CbSize ) { | **Descriptor** |
| … |  |
| if( DmmFlag[ x0 + k ][ y0 + j ] | | sdc\_flag[ x0 ][ y0 ] ) { |  |
| ~~if( CuPredMode[ x0 ][ y0 ] = = MODE\_INTRA && sdc\_flag[ x0 ][ y0 ] )~~ |  |
| **~~depth\_dc\_flag~~**~~[ x0 + k ][ y0 + j ]~~ | ~~ae(v)~~ |
| dcNumSeg = DmmFlag[ x0 + k ][ y0 + j ] ? 2 : 1 |  |
| interFlag = CuPredMode[x0][y0] != MODE\_INTRA ? 1 : 0 |  |
| ~~if( depth\_dc\_flag[ x0 + k ][ y0 + j ] )~~ |  |
| for( i = 0; i < dcNumSeg; i ++ ) { |  |
| **depth\_dc\_abs**[ x0 + k ][ y0 + j ][ i ] | ae(v) |
| if ( depth\_dc\_abs[ x0 + k ][ y0 + j ][ i ] + interFlag>0 ) |  |
| **depth\_dc\_sign\_flag**[ x0 + k ][ y0 + j ][ i ] | ae(v) |
| } |  |
| } |  |
| … |  |
| } |  |

I.7.4.9.5.2 Coding unit extension semantics

**~~depth\_dc\_flag~~**~~[ x0 ][ y0 ] equal to 1 specifies that depth\_dc\_abs[ x0 ][ y0 ][ i ] and depth\_dc\_sign\_flag[ x0 ][ y0 ][ i ] are present. depth\_dc\_flag[ x0 ][ y0 ] equal to 0 specifies that depth\_dc\_abs[ x0 ][ y0 ][ i ] and depth\_dc\_sign\_flag[ x0 ][ y0 ][ i ] are not present. When not present, depth\_dc\_flag[ x0 ][ y0 ] is inferred to be equal to 1.~~

**depth\_dc\_abs**[ x0][ y0 ][ i ], **depth\_dc\_sign\_flag**[ x0 ][ y0 ][ i ]are used to derive DcOffset[ x0 ][ y0 ][ i ]. When not present, the values of depth\_dc\_abs[ x0][ y0 ][ i ] and depth\_dc\_sign\_flag[ x0 ][ y0 ][ i ] are inferred to be equal to 0. The variable DcOffset[ x0 ][ y0 ][ i ] is derived as specified in the following:

DcOffset[ x0 ][ y0 ][ i ] = ( 1 − 2 \*depth\_dc\_sign\_flag[ x0 ][ y0 ][ i ] ) \* ( depth\_dc\_abs[ x0 ][ y0 ][ i ]  +  interFlag  ~~− dcNumSeg +2~~) (I‑37)

Table I‑11 – Association of ctxIdx and syntax elements for each initializationType in the initialization process

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Syntax structure** | **Syntax element** | **ctxTable** | **initType** | | |
| **0** | **1** | **2** |
| cu\_extension( ) intra\_mode\_ext( ) | depth\_intra\_mode\_flag |  | 0 | 1 | 2 |
|  |  |  |  |  |
| ~~depth\_dc\_flag~~ |  | ~~0~~ | ~~1~~ | ~~2~~ |
| depth\_dc\_abs |  | 0..1 | ~~1~~ 2..3 | ~~2~~ 4..5 |
| iv\_res\_pred\_weight\_idx |  |  | 0..2 | 3..5 |
| ic\_flag |  |  | 0 | 1 |
| dbbp\_flag |  | 0 | 1 | 2 |
| sdc\_flag |  | 0 | 1 | 2 |
| dim\_not\_present\_flag |  | 0 | 1 | 2 |

Table I‑12 – Values of initValue for depth\_dc\_abs ctxIdx

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Initialization variable** | **ctxIdx of depth\_dc\_abs** | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** |
| **initValue** | 154 | 154 | 154 | 154 | 154 | 154 |

~~Table ‑16 – Values of initValue for depth\_dc\_flag ctxIdx~~

|  |  |  |  |
| --- | --- | --- | --- |
| **~~Initialization variable~~** | **~~ctxIdx of depth\_dc\_flag~~** | | |
| **~~0~~** | **~~1~~** | **~~2~~** |
| **~~initValue~~** | ~~0~~ | ~~0~~ | ~~64~~ |

Table I‑22 –Assignment of ctxInc to syntax elements with context coded bins

| **Syntax element** | **binIdx** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **0** | **1** | **2** | **3** | **4** | **>=5** |
| wedge\_full\_tab\_idx | bypass | bypass | bypass | bypass | bypass | bypass |
| ~~depth\_dc\_flag~~ | ~~0~~ | ~~na~~ | ~~na~~ | ~~na~~ | ~~na~~ | ~~na~~ |
| depth\_dc\_abs | (sdc\_flag[ x0 ][ y0 ] && CuPredMode[ x0 ][ y0 ] == MODE\_INTRA) | | | bypass | bypass | bypass |
| depth\_dc\_sign\_flag | bypass | 0 | 0 | 0 | 0 | 0 |
| iv\_res\_pred\_weight\_idx | 0, 1 | 2 | na | na | na | na |
| ic\_flag | 0 | na | na | na | na | na |
| dbbp\_flag | 0 | na | na | na | na | na |
| depth\_intra\_mode\_flag | 0 | na | na | na | na | na |
| sdc\_flag | 0 | na | na | na | na | na |
| dim\_not\_present\_flag | 0 | na | na | na | na | na |

# Experimental results

Common test conditions specified in JCT3V-I1100 [2] is used for the evaluation. Table 2-3 show the simulation results of the proposed method (removing depth\_dc\_flag and context model modification ), in which bdrate changes are -0.02% and -0.04% for synthesis in the CTC and all-intra configuration.

**Table 2: Result under CTC (TEST1\_CTC)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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 | 0.00% | -0.08% | -0.03% | 0.00% | 0.00% | -0.01% | 106.5% | 103.9% | 105.7% |
| Kendo | 0.00% | 0.03% | 0.12% | 0.04% | 0.02% | -0.01% | 102.4% | 101.3% | 101.6% |
| Newspaper\_CC | 0.00% | 0.05% | 0.07% | -0.01% | -0.05% | -0.10% | 100.4% | 99.6% | 99.8% |
| GT\_Fly | 0.00% | -0.04% | -0.16% | -0.01% | 0.04% | -0.01% | 101.9% | 101.9% | 101.3% |
| Poznan\_Hall2 | 0.00% | -0.04% | 0.24% | 0.02% | 0.04% | -0.05% | 100.8% | 100.2% | 100.2% |
| Poznan\_Street | 0.00% | 0.11% | 0.11% | 0.03% | 0.06% | 0.03% | 102.2% | 100.5% | 100.8% |
| Undo\_Dancer | 0.00% | -0.21% | -0.03% | -0.03% | -0.01% | -0.08% | 95.5% | 96.9% | 95.6% |
| Shark | 0.00% | 0.02% | -0.04% | 0.00% | 0.08% | 0.10% | 97.6% | 97.2% | 96.5% |
| 1024x768 | 0.00% | 0.00% | 0.05% | 0.01% | -0.01% | -0.04% | 103.1% | 101.6% | 102.4% |
| 1920x1088 | 0.00% | -0.03% | 0.02% | 0.00% | 0.04% | 0.00% | 99.6% | 99.3% | 98.9% |
| **average** | **0.00%** | **-0.02%** | **0.04%** | **0.01%** | **0.02%** | **-0.02%** | **100.9%** | **100.2%** | **100.2%** |

**Table 3: Result under all-intra configuration (TEST1\_AI)**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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 | 0.00% | 0.00% | 0.00% | 0.00% | -0.02% | -0.06% | 99.7% | 99.6% | 99.9% |
| Kendo | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.08% | 97.9% | 97.2% | 97.9% |
| Newspaper\_CC | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.11% | 99.9% | 100.0% | 99.9% |
| GT\_Fly | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.00% | 97.3% | 97.9% | 97.9% |
| Poznan\_Hall2 | 0.00% | 0.00% | 0.00% | 0.00% | -0.03% | -0.07% | 102.5% | 102.1% | 101.5% |
| Poznan\_Street | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | -0.02% | 99.9% | 99.5% | 99.4% |
| Undo\_Dancer | 0.00% | 0.00% | 0.00% | 0.00% | 0.02% | -0.03% | 99.4% | 99.4% | 98.6% |
| Shark | 0.00% | 0.00% | 0.00% | 0.00% | 0.09% | 0.07% | 97.7% | 97.0% | 96.6% |
| 1024x768 | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.08% | 99.2% | 99.0% | 99.2% |
| 1920x1088 | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | -0.01% | 99.4% | 99.2% | 98.8% |
| **average** | **0.00%** | **0.00%** | **0.00%** | **0.00%** | **0.01%** | **-0.04%** | **99.3%** | **99.1%** | **99.0%** |

Additional test:

Additionally we test removing dc offset flag without context modification. Table 4-5 show the simulation results of the proposed method without context model modification, in which bdrate changes are 0.04% and -0.02% for synthesis in the CTC and all-intra configuration.

Table 4: Result under CTC without context model modification (TEST2\_CTC)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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 | 0.00% | -0.14% | 0.04% | -0.01% | 0.00% | 0.08% | 104.1% | 103.7% | 104.9% |
| Kendo | 0.00% | -0.05% | 0.16% | 0.04% | 0.02% | 0.04% | 104.0% | 104.2% | 103.5% |
| Newspaper\_CC | 0.00% | 0.11% | 0.16% | 0.03% | -0.01% | -0.05% | 93.9% | 96.8% | 94.2% |
| GT\_Fly | 0.00% | -0.02% | -0.09% | -0.01% | 0.06% | 0.01% | 100.0% | 101.2% | 100.0% |
| Poznan\_Hall2 | 0.00% | 0.13% | -0.10% | 0.01% | 0.03% | 0.14% | 102.0% | 102.6% | 102.2% |
| Poznan\_Street | 0.00% | 0.05% | 0.00% | 0.02% | 0.06% | 0.01% | 104.8% | 104.3% | 104.5% |
| Undo\_Dancer | 0.00% | -0.21% | -0.12% | -0.02% | 0.00% | -0.07% | 95.7% | 98.5% | 96.3% |
| Shark | 0.00% | 0.10% | 0.10% | 0.02% | 0.12% | 0.15% | 96.0% | 98.0% | 96.2% |
| 1024x768 | 0.00% | -0.02% | 0.12% | 0.02% | 0.00% | 0.02% | 100.7% | 101.6% | 100.9% |
| 1920x1088 | 0.00% | 0.01% | -0.04% | 0.00% | 0.06% | 0.05% | 99.7% | 100.9% | 99.8% |
| **average** | **0.00%** | **0.00%** | **0.02%** | **0.01%** | **0.04%** | **0.04%** | **100.1%** | **101.2%** | **100.2%** |

Table 5: Result under all-intra configuration without context model modification (TEST2\_AI)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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 | 0.00% | 0.00% | 0.00% | 0.00% | -0.02% | -0.06% | 102.0% | 102.1% | 102.0% |
| Kendo | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.06% | 99.8% | 100.1% | 100.0% |
| Newspaper\_CC | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | -0.07% | 101.8% | 102.2% | 101.8% |
| GT\_Fly | 0.00% | 0.00% | 0.00% | 0.00% | 0.05% | 0.01% | 99.4% | 100.7% | 99.8% |
| Poznan\_Hall2 | 0.00% | 0.00% | 0.00% | 0.00% | -0.03% | -0.07% | 96.2% | 98.9% | 96.6% |
| Poznan\_Street | 0.00% | 0.00% | 0.00% | 0.00% | 0.01% | -0.02% | 102.2% | 102.4% | 103.4% |
| Undo\_Dancer | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | -0.01% | 99.3% | 100.4% | 99.5% |
| Shark | 0.00% | 0.00% | 0.00% | 0.00% | 0.11% | 0.10% | 98.0% | 99.7% | 98.5% |
| 1024x768 | 0.00% | 0.00% | 0.00% | 0.00% | -0.01% | -0.06% | 101.2% | 101.5% | 101.3% |
| 1920x1088 | 0.00% | 0.00% | 0.00% | 0.00% | 0.03% | 0.00% | 99.0% | 100.4% | 99.6% |
| **average** | **0.00%** | **0.00%** | **0.00%** | **0.00%** | **0.02%** | **-0.02%** | **99.8%** | **100.8%** | **100.2%** |

# Conclusion

It is asserted that this proposed method can reduce a syntax element named depth\_dc\_flag without significant coding loss. It is recommended to adopt the proposed method into the next 3D-HEVC.

# Patent rights declaration(s)

**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. G. Tech, K. Wegner, Y. Chen and S. Yea, “3D-HEVC Draft Text 5,” JCT3V-I1001, July 2014.
2. K. Müller, A. Vetro, “Common test conditions of 3DV core experiments, JCT3V-I1100, July 2014.
3. 3DV-HTM version 12.0: <https://hevc.hhi.fraunhofer.de/svn/svn_3DVCSoftware/tags/HTM-12.0/>