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| *Title:* | **AHG5: Unified 4x4 and 8x8 significance map coding using one logic** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes a unified context derivation for 4x4 and 8x8 significance map coding by using one lookup table to reduce implementation cost and derivation complexity. It also reduces the number of contexts by 9. It is reported that average BD-rate change is 0.02 % to 0.07 % on common condition ( QP = 22, 27, 32, 37 ) and -0.01 % to 0.05 % on low QP condition ( QP = 12, 17, 22, 27).

# Introduction

The current HM6 [1] uses different derivation process for significant\_coeff\_flag of 4x4 and 8x8 TUs as shown in Figure 1. In several platforms, the process must be implemented using three logics as 4x4 luma logic, 4x4 chroma logic and 8x8 luma / chroma logic. In this case implementation cost is high. Besides the logic of 8x8 needs a number of branches, so complexity is large. Taking into account these problems, a unification and simplification of significant\_coeff\_flag context derivation is needed.

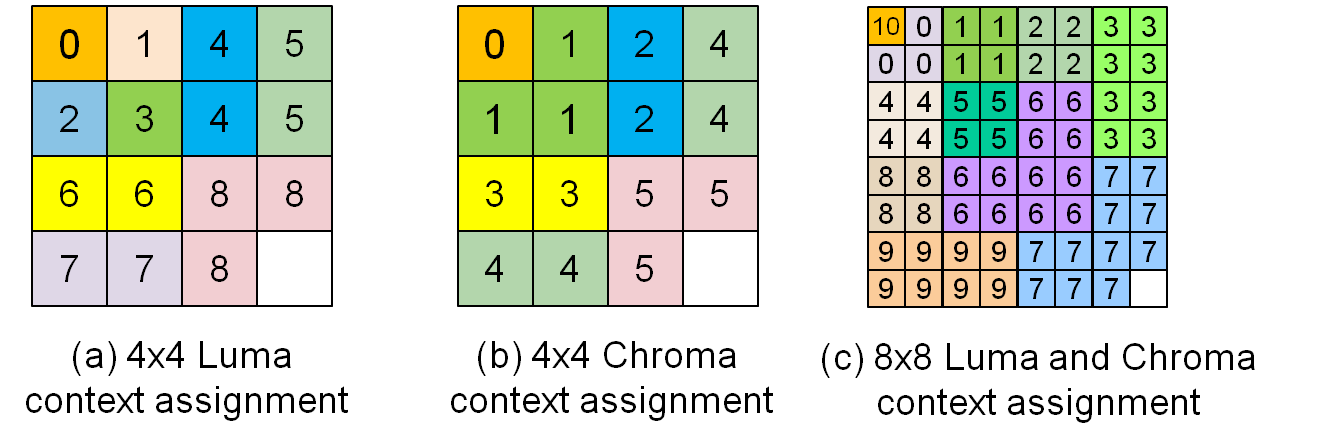


Figure 1: Context assignment of 4x4 and 8x8 significance map coding in HM-6.0

# Technical Description

The proposal is to unify context derivation for 4x4 and 8x8 significance map coding by using one table as shown in Figure 2. By this unification, the context derivation for 4x4 luma, 4x4 chroma and 8x8 luma/chroma is processed by one simplified logic.



Figure 2: The Proposed Context assignment of 4x4 and 8x8 significance map coding

[Example of table derivation]

In the proposal, the context index for 4x4 and 8x8 TUs is derived based on coefficient position with one common table as follows:

Index = (log2TrafoWidth) ==2 ? (yC<<2) + xC: ( ( yC>>1) <<2) + (xC>>1)

sigCtxOffset = log2TrafoWidth==2 ? 0 : 7

sigCtx = sigCtxOffset + ctxIdxMap[ Index ]

Table 1– Specifcation of ctxIdxMap [ i ]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **i** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **ctxIdxMap[i]** | 0 | 1 | 2 | 3 | 1 | 1 | 2 | 3 | 4 | 4 | 6 | 6 | 5 | 5 | 6 | 6 |

[Example of logical derivation]

The context index can be logically derived by using bit operation instead of a lookup table ctxIdxMap.

If( log2TrafoWidth==3 ) { xC>>1; yC>>1; }

sigCtxOffset = log2TrafoWidth==2 ? 0 : 7

sigCtx = ( (y1 << 2) | (x1 <<1) | (x0 & !y1) | (!x1 & y0) )

sigCtx += sigCtxOffset

where x0 = (xC & 1), x1 = xC >> 1, y0 = (yC & 1), y1 = yC >> 1

**Table 2: Relationship between context index and coefficient positions**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | xC | | | |
| 00 | 01 | 10 | 11 |
| yC | 00 | 000 | 001 | 010 | 011 |
| 01 | 001 | 001 | 010 | 011 |
| 10 | 100 | 100 | 110 | 110 |
| 11 | 101 | 101 | 110 | 110 |

Table 2 represents the relationship between context index and coefficient positions (xC, yC ), where value and positions are expressed in binary digit. The context index is consists of three bits: the value highlighted in green, yellow, and blue. As you can see, the lowest bit (green) can be derived by x0, x1, y0 and y1. The second lowest bit (yellow) can be derived by x1. The third lowest bit (blue) can be derived by y1.

The benefits of the proposal are summarized as follows:

* Context derivation process is unified
* Simplified derivation on both table implementation and logical implementation
* The number of contexts is reduced by 9

# Complexity analysis

This section provides complexity analysis compared between our proposal and related contributions[3,4,5,6] regarding unification of 4x4 and 8x8 significance map with one lookup table.

In this meeting, there are four context mapping table proposed for unification of 4x4 and 8x8 significance map as shown in Figure 3.

The table shown in Figure 3(a) is proposed in our proposal and C30 and C28 of [6].

The table shown in Figure 3(b) is proposed in [3,4,5], which is the same as 4x4 luma table in HM6.

The table shown in Figure 3(c) is proposed in C38 and C36 of [6], which is used different numbering from Figure 3(b).

The table shown in Figure 3(d) is proposed in C34 and C32 of [6].

図3.png

Figure : Context mapping table for 4x4 and 8x8 significance map coding.

It is possible to derive the value of each above context mapping table by using following logical operation instead of using those lookup tables.

Figure3 (a): value = (y1 << 2) | (x1 <<1) | {(x0 & !y1) | (!x1 & y0) } - (eq.1)

Figure3 (b): value = {( x1 & y1 )<<3} |   
 { (( x1 & !y1) | ( !x1 & y1))<<2 } |

{ (( !x1 & y1) | ( !x1 & !y1 & y0))<<1} |

{ ( x0 &!y1) | ( y0 & y1 & !x1 ) } -(eq.2)

Figure3 (c): value = ((!x1 & x0 & !y1 & y0)<<3) |

{(y1 | (!x1 & !x0) & ( y1 | y0))<<2} |

{(x1 | !( x0 | x1 | y1 | !y0))<<1} |

{(y1 & y0 & !x1) | (x1 & x0 & !y1) | !( x0 | x1 | y1 | !y0) | !(y0 | y1 | x1 | !x0) }

-(eq.3)

Figure3 (d): value = {( y1 | !x1 & ( y1 | y0))<<2 } |

{(x1 | (!y1 & y0)) <<1} |

{ (x0 & !y1) | (!x1 & y0) } -(eq.4)

where, x0 = (xC & 1), x1 = xC >> 1, y0 = (yC & 1), y1 = yC >> 1

Note that coefficient position (xC, yC) is right shifted if TU is 8x8 before calculating x0, x1, y0, and y1.

Note that (eq.2) to (eq.4) can be optimized more.

Table 4 shows the number of operator to be required for deriving the value of the context mapping table by using above logical operation (eq.1) to (eq.4) after calculating x0, x1, y0, and y1.

**Table 4: The number of operator to be required for deriving the value of the context mapping table regarding our proposal and [3, 4, 5, 6]**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **operator** | | | |  |
| **“<<”**  **(bit shift)** | **“&”**  **(logical And)** | **“|”**  **(logical OR)** | **“!”**  **(logical Not)** | **Total** |
| **Figure3(a) (eq.1)** | 2 | 2 | 3 | 2 | 9 |
| **Figure3(b) (eq.2)** | 3 | 9 | 6 | 7 | 25 |
| **Figure3(c) (eq.3)** | 3 | 9 | 16 | 10 | 38 |
| **Figure3(d) (eq.4)** | 2 | 4 | 6 | 4 | 16 |

# Simulation results

The proposal was implemented on the top of HM-6.0. The simulations were performed based on common condition and low QP condition. Table 1 and 2 summarize the results of the experiments.

**Table 1: Performance of the proposal (common condition)**



**Table 2: Performance of the proposal (QP = 12, 17, 22, 27)**



# Conclusion

In this document, a unified context derivation for 4x4 and 8x8 significance map coding is proposed. In this proposal, the derivation process is unified and simplified. It also reduces the number of context by 9 (about 25%, 9/37). The performance loss is negligible (up to 0.1 %). We recommend the proposal to be adopted as a part of the next HM.

# References

[1] B. Bross, W-J Han, J-R Ohm, G. J. Sullivan, and T. Wiegand, “High efficiency video coding (HEVC) text specification draft 6,” JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 8th Meeting: San José, USA, 1-10 February, 2012

[2] T. Tsukuba, T. Ikai, V. Seregin, J. Sole, M. Karczewicz, “Non-CE11.1: Context reduction of significance map coding,” JCTVC-H0100, JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 8th Meeting: San José, USA, 1-10 February, 2012.

[3] Gergely Korodi, Dake He, Gaëlle Martin-Cocher, “AHG5- Coefficient coding – significance map clean-up, ” JCTVC-I0031, JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 9th Meeting: Geneva, CH, 27 April – 7 May 2012

[4] Chih-Wei Hsu, Tzu-Der Chuang, Yu-Wen Huang, Shawmin Lei, “AHG5: Unified context selection for significance map coding of 4x4 and 8x8 TUs, ” JCTVC-I0155, JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 9th Meeting: Geneva, CH, 27 April – 7 May 2012

[5] Jianle Chen, Joel Sole, Wei-Jung Chien, Vadim Seregin, Marta Karczewicz, “AHG5- context derivation clean-up for significance map, ” JCTVC-I0378, JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 9th Meeting: Geneva, CH, 27 April – 7 May 2012

[6] Cheung Auyeung, “Harmonization and complexity reduction of context selection of 4x4 and 8x8 significant\_coeff\_flag, ” JCTVC-I0271, JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 9th Meeting: Geneva, CH, 27 April – 7 May 2012

# Proposed CD text

Please see the attached text.

# Patent rights declaration(s)

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