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| --- | --- |
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| --- | --- | --- | --- |
| *Title:* | Non-CE11.1: Context reduction of significance map coding | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

In this contribution, simplified context derivation for both 4x4 and 8x8 blocks in the significant \_coeff\_flag coding. The proposed method uses a common loop-up table for both 4x4 and 8x8 and reduces 11 contexts. It is reported, average BD-rate change is 0.01% to 0.07% on common condition ( QP = 22, 27, 32, 37) and -0.02% to 0.05% on low QP condition ( QP = 12, 17, 22, 27).

# Introduction

Atsignificant\_coeff\_flag coding, HM-5.0 uses a total of 37 contexts for 4x4 and 8x8 blocks: 9 for 4x4 luma , 6 for 4x4 chroma and 11 for 8x8 luma and chroma as shown in Figure 1[2]. Context index for 4x4 and 8x8 blocks is derived based on coefficient position (xC, yC) and the lookup tables as follows:

* If log2TrafoWidth is equal to log2TrafoHeight and log2TrafoWidth is equal to 2, sigCtx is derived using ctxIdxMap4x4[ ] specified in Table 9‑39 as follows..

sigCtx = ctxIdxMap4x4[ ((cIdx > 0) ? 15 : 0) + (yC << 2) + xC ] (9‑55)

* Otherwise if log2TrafoWidth is equal to log2TrafoHeight and log2TrafoWidth is equal to 3, sigCtx is derived using ctxIdxMap8x8[ ] specified in Table 9‑40 as follows.

sigCtx = ((xC + yC) = = 0) ? 10 : ctxIdxMap8x8[ ((yC >> 1 ) << 2) + (xC >> 1) ] (9‑56)

sigCtx += ( cIdx > 0) ? 6: 9 (9‑57)

Table ‑ – Specifcation of ctxIdxMap4x4[ i ]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **I** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
| **ctxIdxMap4x4[ i ]** | 0 | 1 | 4 | 5 | 2 | 3 | 4 | 5 | 6 | 6 | 8 | 8 | 7 | 7 | 8 |
| **I** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** |
| **ctxIdxMap4x4[ i ]** | 0 | 1 | 2 | 4 | 1 | 1 | 2 | 4 | 3 | 3 | 5 | 5 | 4 | 4 | 5 |

Table ‑ – Specifcation of ctxIdxMap8x8[ i ]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **I** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **ctxIdxMap8x8[ i ]** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 3 | 8 | 6 | 6 | 7 | 9 | 9 | 7 | 7 |

In the case of 8x8 block, as shown in eq.(9-56), context index for DC is derived based on the coefficient position, while the others are derived as the position of 2x2 sub-block and a lookup table. Therefore, it requires one conditional branch process for classifying the lower 4 frequency components into a DC component and AC components.

In the current design, there exist the following issues;

* The sizes of the look-up tables are large.
* In 8x8 block, it is complicated to classify the lower 4 frequency into a DC component and AC components.
* The number of contexts can be reduced.

In order to solve those issues, the proposed method is presented in the next section.

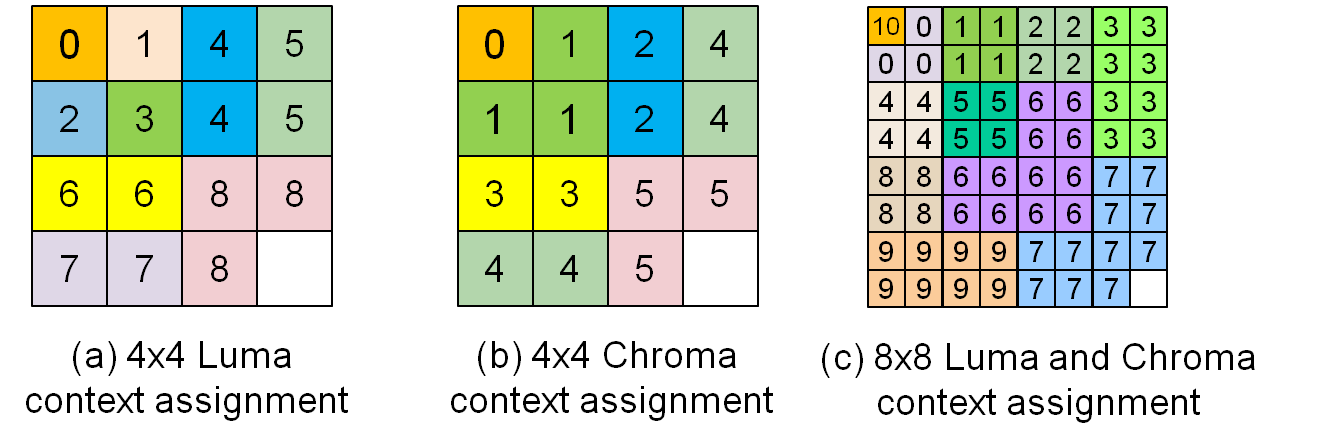


Figure 1: Context assignment of 4x4 and 8x8 significance map coding in HM-5.0

# Proposal

The proposed method is to use a similar context assignment for 4x4 and 8x8 blocks of each color component as shown in Figure 2.



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

In the proposal, context index for 4x4 and 8x8 blocks is derived based on coefficient position and lookup tables as follows:

* If log2TrafoWidth is equal to log2TrafoHeight and log2TrafoWidth is less than or equal to 3 and cIdx is equal to 0, sigCtx is derived using ctxIdxMapLuma [ ] specified in Table 9‑39 as follows..

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

sigCtxOffset = log2TrafoWidth==2 ? 0 : 7

~~sigCtx = ((xC + yC) = = 0) ? 10 : ctxIdxMap8x8[ ((yC >> 1 ) << 2) + (xC >> 1) ] (9‑56)~~

sigCtx = sigCtxOffset + ctxIdxMapLuma[ Index ] (9‑55)

* Otherwise if log2TrafoWidth is equal to log2TrafoHeight and log2TrafoWidth is less than or equal to 3 and cIdx is equal to 1, sigCtx is derived using ctxIdxMapChroma [ ] specified in Table 9‑40 as follows.

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

sigCtxOffset = logTrafoWidth==2 ? 0 : 6

sigCtx = sigCtxOffset + ctxIdxMapChroma [ Index ] (9‑56)

Table 9‑39 – Specifcation of ctxIdxMapLuma [ i ]

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

Table ‑ – Specifcation of ctxIdxMapChroma[ i ]

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

In the proposed method, the lookup table for 8x8 is removed so that the table for 4x4 block is used for both 4x4 and 8x8 blocks. The DC classification of 8x8 block is also removed.

The benefits of the proposed method are summarized as follows:

* The number of contexts is reduced by 11
* DC classification of 8x8 block is removed.
* One lookup table ctxIdxMap8x8 is removed

# Simulation results

The proposal is implemented on HM-5.0. 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 proposed method (common condition)**

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

# Conclusion

In this document, a modification of significance map coding for 4x4 and 8x8 blocks is proposed. In this proposal,the number of context for 4x4 and 8x8 blocks is reduced by 11 (about 30%, 11/37) and context derivation process is simplified by using the common lookup table for luma and chroma and removing DC classification of 8x8 block. 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. Vivienne Sze, “Description of Core Experiment (CE11): Coefficient scanning and coding,” JCTVC-G1211, 7th Meeting: Geneva, CH, 21-30 November, 2011.
2. B. Bross, W-J Han, J-R Ohm, G. J. Sullivan, and T. Wiegand, “WD5: Working Draft 5 of High-Efficiency Video Coding,” JCT-VC of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, 7th Meeting, Geneva, November, 2011.

# Proposed WD text

The changes of WD text are highlighted in yellow. The base text is JCTVC-G1103[2].

Table 9‑27 – Values of variable initValue for significant\_coeff\_flag ctxIdx

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Initialisation variable** | **significant\_coeff\_flag ctxIdx** | | | | | | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** |
| **initValue** | 74 | 72 | 72 | 55 | 71 | 54 | 71 | 88 | 134 | 71 | 53 | 70 | 68 | 84 | 90 | 84 |
|  | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
| **initValue** | 88 | 74 | 130 | 118 | 88 | 120 | 87 | 149 | 52 | 70 | 118 | 133 | 162 | 114 | 129 | 115 |
|  | **32** | **33** | **34** | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** | **46** | **47** |
| **initValue** | 51 | 74 | 115 | 87 | 89 | 152 | 118 | 87 | 70 | 70 | 53 | 118 | 134 | 101 | 101 | 68 |
|  | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** | **57** | **58** | **59** | **60** | **61** | **62** | **63** |
| **initValue** | 68 | 67 | 100 | 168 | 147 | 150 | 120 | 115 | 118 | 119 | 136 | 102 | 70 | 67 | 53 | 117 |
|  | **64** | **65** | **66** | **67** | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** | **79** |
| **initValue** | 102 | 115 | 115 | 114 | 83 | 100 | 168 | 131 | 150 | 120 | 152 | 118 | 87 | 70 | 70 | 53 |
|  | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** | **88** | **89** | **90** | **91** | **92** | **93** | **94** | **95** |
| **initValue** | 71 | 103 | 101 | 101 | 68 | 68 | 67 | 116 | 168 | 147 | 150 | 120 | 115 | 118 | 119 | 136 |
|  | **96** | **97** | **98** | **99** | **100** | **101** | **102** | **103** | **104** | **105** | **106** | **107** | **108** | **109** | **110** |  |
| **initValue** | 102 | 86 | 67 | 84 | 117 | 102 | 115 | 115 | 99 | 83 | 100 | 152 | 131 | 150 | 120 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **initValue** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **initValue** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

## Proposed changes to “9.2.3.1.1.5 Derivation process of ctxIdxInc for the syntax element significant\_coeff\_flag”

Inputs to this process are the color component index cIdx, the current coefficient scan position ( xC , yC ), the transform block width log2TrafoWidth and the transform block height log2TrafoHeight.

Output of this process is ctxIdxInc.

The variable sigCtx depends on the current position ( xC, yC ), the color component index cIdx, the transform block size and previsously decoded bins of the syntax element significant\_coeff\_flag. For the derivation of sigCtx, the following applies.

* If log2TrafoWidth is equal to log2TrafoHeight and log2TrafoWidth is less than or equal to 3 and cIdx is equal to 0, sigCtx is derived using ctxIdxMapLuma [ ] specified in as follows.

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

sigCtxOffset = log2TrafoWidth==2 ? 0 : 7

sigCtx = sigCtxOffset + ctxIdxMapLuma[Index] (9‑55)

* Otherwise if log2TrafoWidth is equal to log2TrafoHeight and log2TrafoWidth is less than or equal to 3 and cIdx is equal to 1, sigCtx is derived using ctxIdxMapChroma [ ] specified in as follows.

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

sigCtxOffset = logTrafoWidth==2 ? 0 : 6

sigCtx = sigCtxOffset + ctxIdxMapChroma [ Index ] (9‑56)

* Otherwise if xC + yC is equal to 0, sigCtx is derived as follows.

sigCtx = ( cIdx > 0) ? 14: 12 (9‑57)

* Otherwise (xC + yC is greater than 0), sigCtx is derived using previously decoded bins of the syntax element significant\_coeff\_flag as follows.
* The variable sigCtx is initialized as follows.

sigCtx = 0 (9‑58)

* When xC is less than ( 1 << log2TrafoWidth ) − 1, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC + 1 ][ yC ] (9‑59)

* When xC is less than ( 1 << log2TrafoWidth ) − 1 and yC is less than ( 1 << log2TrafoHeight ) − 1, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC + 1 ][ yC + 1 ] (9‑60)

* When xC is less than ( 1 << log2Width ) − 2, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC + 2 ][ yC ] (9‑61)

* When all of the following conditions are true,
  + yC is less than ( 1 << log2TrafoHeight ) − 1,
  + xC % 4 is not equal to 0 or yC % 4 is not equal to 0,
  + xC % 4 is not equal to 3 or yC % 4 is not equal to 2,

the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC ][ yC + 1 ] (9‑62)

* When yC is less than ( 1 << log2TrafoHeight ) − 2 and sigCtx is less than 4, the following applies.

sigCtx = sigCtx + significant\_coeff\_flag[ xC ][ yC + 2 ] (9‑63)

* The variable sigCtx is modified as follows.
  + If cIdx is equal to 0 and xC + yC are greater than (1 << (max(log2TrafoWidth, log2TrafoHeight) − 2)) − 1, the following applies.

sigCtx = ( (sigCtx + 1) >> 1 ) + 18 (9‑63)

* + Otherwise, the following applies.

sigCtx = ( (sigCtx + 1) >> 1 ) + ( (cIdx > 0) ? 13 : 15 ) (9‑63)

The context index increment ctxIdxInc is derived using the color component index cIdx and sigCtx as follows.

* If cIdx is equal to 0, ctxIdxInc is derived as follows.

ctxIdxInc = sigCtx (9‑64)

* Otherwise (cIdx is greater than 0), ctxIdxInc is derived as follows.

ctxIdxInc = 21 + sigCtx (9‑65)

Table 9‑39 – Specifcation of ctxIdxMapLuma [ i ]

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

Table 9‑40 – Specifcation of ctxIdxMapChroma[ i ]

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

# Patent rights declaration(s)

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