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| *Title:* | **Non-CE6: Modifications of intra mode coding** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution presents a coding method to signal the intra prediction mode. By removing one prediction direction from HM5.0, syntax element of remaining mode, **rem\_intra\_luma\_pred\_mode,** in the intra mode coding can be signaled with fixed length codes. The number of available intra prediction mode over PUs with variant sizes is also suggested to be unified in this contribution. And for further simplification, it is proposed to remove luma intra modes mapping. Experimental results reportedly show no BD-rate changes for all intra configurations under common test condition.

# Introduction

In current HEVC design (HM5.0), the available intra prediction modes for Luma component are 18 ( from 0 to 17) for a 4×4 block and 35 for a block which is larger than 4×4. Fig.1 shows all intra mode numbers and associated angular prediction directions. Two issues are existed in the current design. First, there is a larger gap on the prediction direction between mode 9 and mode 10 for a 4x4 block. Second, when signaling a chosen intra mode, variable length codes are needed to represent the remaining mode (**rem\_intra\_luma\_pred\_mode**) for a block larger than 4×4. There are 33 different values of the remaining mode set, a 5-bits fixed length code cannot sufficiently cover all values in the set and the last two modes are represented with escape code in current HM.

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22

1

23

13

24

6

25

26

14

7

3:

Intra\_DC

0:

Intra\_Planar

27

15

28

8

29

16

30

2

31

17

32

9

33

18

34

10

Fig.1. Intra mode numbers and associated angular prediction directions.

# Proposed solution

**2.1 Removing one angular prediction direction**

In this contribution, we propose to remove one angular prediction direction (mode 10) from Fig.1. The mode mapping is adjusted accordingly by reducing mode number for the mode 11 to 34 by 1, as shown in Fig.2. The available intra prediction modes for Luma component are 18 for a 4×4 block and 34 for a PU which is larger than 4×4. As a result, fixed length codes (FLC) can represent the remaining mode, where 4 and 5 bits FLC are used, respectively. By removing mode 10 from Fig.1, the prediction direction gap for 4×4 PU is then filled.

**2.2 Unifying the available intra prediction modes for all PU sizes**

To further simplify the intra mode coding, we propose to unify the available intra prediction modes for all block sizes based on section 2.1. All 34 modes are suggested to be used and mode mapping rules for different block sizes are thus removed.

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Intra\_DC

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Intra\_Planar

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Fig.2. Proposed Intra mode numbers and associated angular prediction directions (removing mode 10 from Fig.1 and reduce mode number by one for mode 11 to 34)

**2.3 Intra mode mapping removal**

Simplification of the luma intra mode representation and coding was also studied in this contribution.

In current HM, luma intra mode mapping between logical intra mode index and intra mode, signaled in a bit stream, is done with g\_aucAngIntraModeOrder table.

In this method, it is proposed to remove this mapping procedure and use only intra mode index. And all the tables, where luma intra mode is used as an input, such as scanning MDCS and intra smoothing MDIS were updated, reflecting the new ordering of intra modes, however values in these table are kept the same as anchor.

Removal of mapping procedure for luma intra modes was implemented on top of 2.1 and results are summarised in Table 4.3.

**2.4 Intra mode mapping removal with 34 intra modes used in all CUs**

Additionally to intra mode mapping removal described in 2.3, 34 intra modes as mentione in section 2.2 were assigned for 4x4 . In this case all the CUs have the same number of intra modes as 34 and table g\_aucIntraModeNumAng, defining number of intra modes for each CU size, is no longer need.

Removal of mapping procedure for luma intra modes was implemented on top of 2.1+2.2 and results are summarised in Table 4.4.

# Simulation results

The proposed methods, summarized in the next table, are implemented on HM 5.0 and simulated under the common test conditions [1]. The performance is compared to HM5.0 anchor in terms of Bjøntegaard Delta (BD) Bit Rate.

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| Test 2.1 | Removing one angular prediction direction | Table 4.1 |
| Test 2.2 | 2.1 + 34 intra modes for all CUs | Table 4.2 |
| Test 2.3 | 2.1 + luma intra mapping removal | Table 4.3 |
| Test 2.4 | 2.2 + luma intra mapping removal | Table 4.4 |

Table 4.1 and 4.2 summarizes the experimental results of the methods mentioned in section 2.1 and section 2.2, respectively. Table 4.3 and 4.4 summarizes the experimental results of the methods for test 2.3 and test 2.4, respectively.

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| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class B | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class D | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class E | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
|  | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 101% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | |

Table 4.1 BD-rate saving of the proposed algorithm (Section 2.1) against HM5.0.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | 0.1% | 0.0% | 0.1% | 0.0% | 0.1% | 0.0% |
| Class B | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% |
| Class C | 0.0% | 0.0% | 0.0% | -0.2% | 0.0% | 0.0% |
| Class D | 0.0% | 0.1% | 0.1% | -0.1% | 0.2% | 0.1% |
| Class E | 0.0% | 0.1% | 0.1% | -0.1% | 0.1% | 0.1% |
| **Overall** | 0.0% | 0.0% | 0.0% | -0.1% | 0.1% | 0.0% |
|  | 0.0% | 0.0% | 0.0% | -0.1% | 0.1% | 0.0% |
| Enc Time[%] | 103% | | | 106% | | |
| Dec Time[%] | 100% | | | 100% | | |

Table 4.2 BD-rate saving of the proposed algorithm (Section 2.2) against HM5.0.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | -0.01% | 0.00% | 0.03% | -0.02% | 0.05% | 0.05% |
| Class B | 0.01% | 0.02% | 0.04% | 0.01% | 0.02% | 0.04% |
| Class C | 0.02% | 0.00% | 0.04% | 0.02% | 0.02% | 0.01% |
| Class D | 0.02% | 0.10% | 0.04% | 0.03% | 0.03% | 0.02% |
| Class E | 0.05% | 0.04% | 0.11% | 0.04% | 0.04% | 0.09% |
| **Overall** | 0.02% | 0.03% | 0.05% | 0.02% | 0.03% | 0.04% |
|  | 0.02% | 0.03% | 0.06% | 0.02% | 0.03% | 0.04% |
| Class F | 0.10% | 0.00% | 0.11% | 0.14% | 0.11% | 0.07% |
| Enc Time[%] | 99% | | | 99% | | |
| Dec Time[%] | 100% | | | 100% | | |

Table 4.3. Experimental results for luma intra mode mapping removal (section 2.3)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | 0.12% | 0.05% | 0.06% | 0.04% | 0.12% | 0.06% |
| Class B | 0.03% | -0.01% | -0.01% | 0.01% | -0.04% | -0.05% |
| Class C | -0.04% | 0.01% | 0.04% | -0.17% | 0.03% | 0.01% |
| Class D | 0.03% | 0.11% | 0.11% | -0.12% | 0.21% | 0.16% |
| Class E | 0.04% | 0.09% | 0.12% | -0.08% | 0.10% | 0.12% |
| **Overall** | 0.03% | 0.04% | 0.06% | -0.07% | 0.07% | 0.05% |
|  | 0.03% | 0.04% | 0.06% | -0.07% | 0.07% | 0.05% |
| Class F | -0.16% | 0.11% | 0.13% | -0.30% | 0.44% | 0.14% |
| Enc Time[%] | 100% | | | 102% | | |
| Dec Time[%] | 101% | | | 100% | | |

Table 4.4. Experimental results for luma intra mode mapping removal and assigning 34 luma intra modes for 4x4 CU (section 2.4).

# Conclusions

This contribution proposed a simplified intra mode coding method that uses fixed length codes to code **rem\_intra\_luma\_pred\_mode** and unifies the available angular directions for all block sizes. Furthermore, the table of luma intra mode mapping was removed. The simulation results show the average performance gain change is insignificant.

# Reference

[1] F. Bossen, “Common HM test conditions and software reference configurations”, JCTVC-G1200, Geneva, Dec, 2011.

# Patent rights declaration(s)

**Qualcomm 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).**