JCTVC-F509:
CE6.a: Report of Bidirectional UDI mode for Intra prediction

Yongbing Lin, Haitao Yang, Changcai Lai,

Jianhua Zheng, Lingzhi Liu

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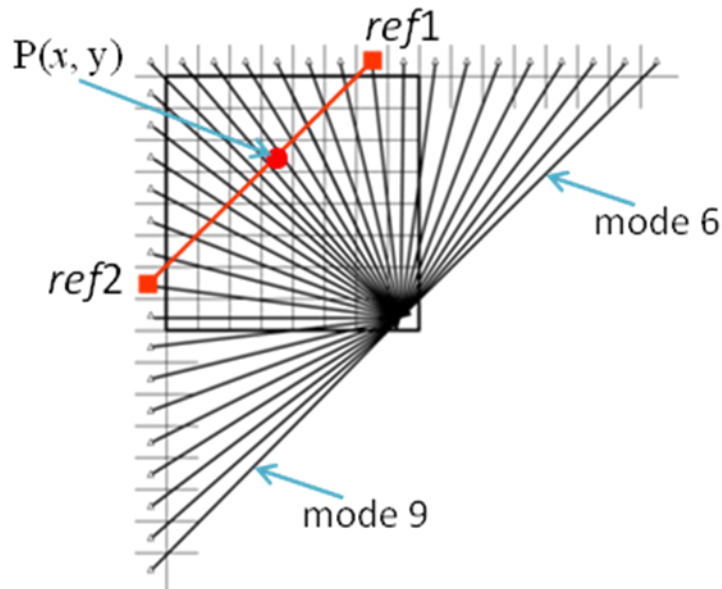
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Introduction

- **Observation**

  - Intra prediction in HM exploits 2 non-directional modes (DC and Planar), and up to 33 angular modes. Two issues are identified:
    - `Redundancy in Intra mode 6 and 9:` Both Intra mode 6 and 9 are actually expected to predict the same texture in direction of 45 degree.
    - `Parsing dependency for DC and Planar modes:` one additional flag is signaled when mode number is equal to 2.

- **Proposal**

  - Intra mode 6 and 9 are unified as a bi-prediction mode (BUDI). Two techniques of BUDI have been implemented
    - LUT-based and LUT-free
  - Different Intra mode signaling are investigated
    - 1) BUDI replaces either mode 6 or mode 9.
    - 2) Harmonized signaling method for BUDI, DC and Planar modes with number of 2, 6 and 9. Thus no additional flag is required for signaling DC and Planar mode. It solves the parsing dependency issue.

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Bi-directional prediction (BUDI)

P(x, y) = w1*ref1 + w2*ref2

- **LUT-based**

  - $w1 = (x+1) / (y+x+2)$

  - $w2 = (y+1) / (y+x+2)$

  - where the division operation is implemented with a LUT

- **LUT-free**

  - $w1 = (nS + (x-y)) / (2*nS)$

  - $w2 = (nS - (x-y)) / (2*nS)$

  - where the division operation can be replaced by shifting

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Intra mode signaling

- **1) BUDI replaces Intra mode 6**

- **2) Harmonized signaling method for BUDI, DC and Planar modes**

  - 2.a : (DC, BUDI, Planar) = (2, 6, 9), which means Intra mode signaling for DC, BUDI and Planar with 2, 6 and 9, respectively.

  - 2.b : (DC, BUDI, Planar) = (9, 6, 2);

  - 2.c : (DC, BUDI, Planar) = (2, 9, 6);

  - 2.d : (DC, BUDI, Planar) = (6, 9, 2);

Table-1 Assignment of Intra mode number

combination case	DC	BUDI	Planar
2.a : (DC, BUDI, Planar) = (2, 6, 9)	2	6	9
2.b : (DC, BUDI, Planar) = (9, 6, 2)	9	6	2
2.c : (DC, BUDI, Planar) = (2, 9, 6)	2	9	6
2.d : (DC, BUDI, Planar) = (6, 9, 2)	6	9	2

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Test results (1) ––––
BUDI with replacement of mode 6

Table-1 Performance of BUDI on top of HM3.0

Method	AI − HE					AI − LC				
	BD-rate			Run time		BD-rate			Run time	
	Y	U	V	Enc	Dec	Y	U	V	Enc	Dec
LUT-based BUDI	-0.17	0.0	0.1	100%	100%	-0.18	-0.1	0.0	101%	100%
LUT-free BUDI	-0.13	0.1	0.1	100%	100%	-0.14	0.0	0.0	100%	100%

Table-2 Performance of BUDI on top of HM3.0-SDIP branch

Method	AI − HE					AI − LC				
	BD-rate			Run time		BD-rate			Run time	
	Y	U	V	Enc	Dec	Y	U	V	Enc	Dec
LUT-based BUDI	-0.19	0.0	0.0	99%	100%	-0.20	-0.1	-0.1	100%	100%
LUT-free BUDI	-0.14	0.1	0.1	100%	99%	-0.15	0.0	0.0	99%	99%

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Test results (2) ––––
Harmonized signaling for BUDI, DC and Planar

Table-3 Performance of the different combinations for **LUT-based BUDI** on the top of HM3.0

Method combination	AI - HE					AI – LC				
	BD-rate			Run time		BD-rate			Run time	
	Y	U	V	Enc	Dec	Y	U	V	Enc	Dec
2.a	**-0.17**	**0.0**	**0.0**	**97%**	**100%**	**-0.23**	**0.0**	**0.0**	**96%**	**101%**
2.b	-0.23	0.1	0.1	97%	100%	-0.28	0.1	0.2	96%	101%
2.c	-0.16	0.0	0.0	97%	100%	-0.21	0.0	0.0	96%	101%
2.d	-0.23	0.1	0.1	97%	100%	-0.27	0.1	0.2	96%	101%

Table-4 Performance of the different combinations for **LUT-free BUDI** on the top of HM3.0

Method combination	AI - HE					AI – LC				
	BD-rate			Run time		BD-rate			Run time	
	Y	U	V	Enc	Dec	Y	U	V	Enc	Dec
2.a	**-0.12**	**0.0**	**0.0**	**97%**	**100%**	**-0.19**	**0.0**	**0.0**	**95%**	**100%**
2.b	-0.19	0.1	0.2	97%	100%	-0.24	0.1	0.2	96%	100%
2.c	-0.12	0.0	0.0	97%	100%	-0.18	0.0	0.0	96%	100%
2.d	-0.18	0.1	0.1	97%	100%	-0.23	0.2	0.2	96%	101%

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Conclusion

- BUDI with harmonized Intra mode signaling

- **Improved performance:**

  - 0.1-0.3% gain for all Intra configurations

- **Reduced run-time:**

  - reducing 3-5% encoding time

- **Better harmonized Intra mode signaling:**

  - avoid the parsing dependency issue on decoding DC and Planar mode

- We recommend to include **2.a combination** into HM test model

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Thank you

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