

JCTVC-G572: Reference Sample Padding Harmonization for Intra DC Mode

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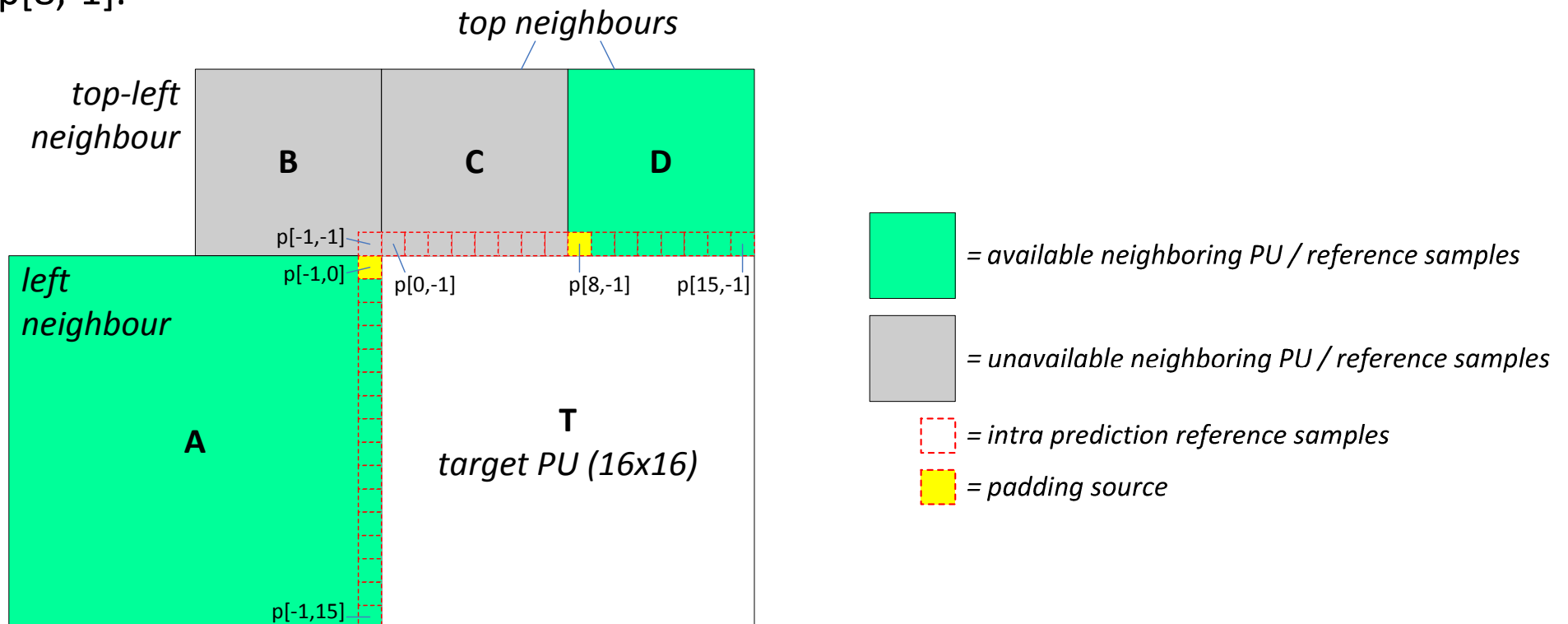
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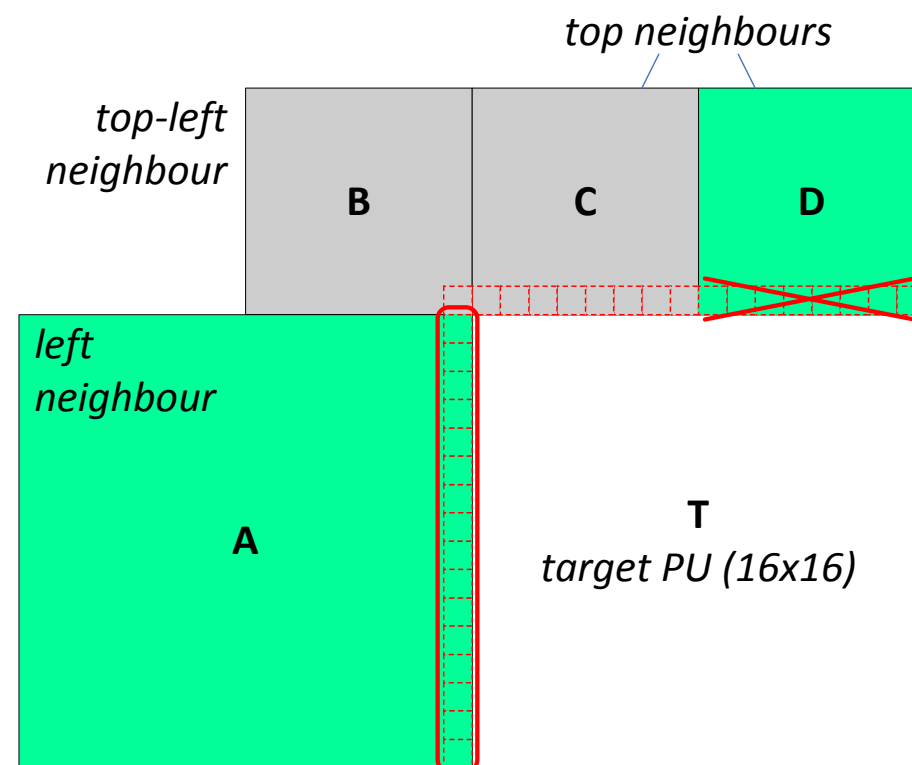
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7th JCT-VC meeting, Geneva, CH, 21-30 Nov 2011

- Intra reference sample padding in HM-3.x/4.x:
 - ❑ Unavailable reference samples are substituted with values calculated from nearest adjacent available samples → by direct copy or simple interpolation.
 - ❑ After padding, all reference samples become available for intra prediction.
- Due to padding, DC prediction value becomes a weighted average of the "originally available" reference samples, i.e., the samples marked as available before padding.
- In the example, samples $p[-1,-1]$ to $p[7,-1]$ are padded with the value $((p[-1,0] + p[8,-1] + 1) \gg 1)$. DC prediction value for block T is thus averaged over repetitions of $p[-1,0]$ and $p[8,-1]$.



- Proposed solution:
 - ❑ Calculate the DC prediction value from a neighboring side (top/left) when all reference samples of that particular side are “originally available”.
 - ❑ *[Harmonization with DC prediction filtering in HM-4.x]* Filter only the DC prediction samples adjacent to an “originally available” neighbouring side.
- In the example, 16 reference samples from block A are used for calculating DC prediction value, while samples in block D are not used. Perform filtering only the left column of DC prediction samples ($p[0,0]$ to $p[0,15]$) and do not filter the top row of DC prediction samples ($p[1,0]$ to $p[15,0]$).
- Coding efficiency may be sub-optimum because the side with partial “originally available” samples are not used. However, experimental results show small BD-rate gain from this solution.



- Results are shown for common test settings with CIP=1 and 1500-byte slices (HM-4.0 rev 1354). Similar results was previously reported in JCTVC-F414.
- Proposed solution gives small but consistent gain especially in intra-only cases.
- No effect on encoding & decoding run times.
- We thank NEC for providing cross-check and additional results in JCTVC-G897.

Intra	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%	-0.2%
Class B	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%
Class C	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class D	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class E	-0.1%	-0.1%	-0.2%	-0.1%	-0.2%	-0.2%
All	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.2%
Enc Time	100%			100%		
Dec Time	100%			100%		

HB7	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.0%	0.0%	-0.2%	0.0%	0.0%	-0.1%
Class B	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	0.0%
Class C	0.0%	0.0%	-0.2%	-0.1%	0.1%	0.0%
Class D	0.0%	-0.1%	0.1%	0.0%	0.0%	0.0%
Class E						
All	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%
Enc Time	100%			100%		
Dec Time	101%			100%		

IBBB	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	0.0%	0.2%	-0.1%	0.0%	0.1%	-0.2%
Class C	0.0%	-0.1%	0.1%	0.0%	0.1%	0.0%
Class D	0.0%	-0.5%	-0.4%	0.0%	0.4%	0.0%
Class E	0.0%	0.2%	1.0%	-0.1%	0.8%	0.0%
All	0.0%	0.0%	0.1%	0.0%	0.3%	-0.1%
Enc Time	100%			100%		
Dec Time	100%			100%		

- Padding enables all directional intra modes to be performed regardless of reference sample availability.
- A small issue is reported on harmonization between reference sample padding and intra DC prediction, where DC prediction value becomes a non-uniform average value due to padding.
- A straightforward solution is presented, producing small but consistent coding gain (average 0.1% BD-rate reduction for intra-only settings).
- It is recommended that JCT-VC:
 - Consider the trade-off between design simplicity and conceptual accuracy of intra DC prediction, noting the small effect on coding performance;
 - If conceptual accuracy is desired, adopt the proposed solution.

Thank you

Supplementary Result

- Previous result using HM-3.1

Intra	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class B	-0.1%	-0.1%	-0.2%	-0.1%	-0.1%	-0.2%
Class C	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class D	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class E	-0.1%	-0.1%	-0.2%	-0.1%	-0.3%	-0.2%
All	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Enc Time	100%			100%		
Dec Time	100%			100%		

HB7	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%
Class B	0.0%	0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class C	0.0%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%
Class D	-0.1%	0.0%	-0.3%	0.0%	-0.1%	0.0%
Class E						
All	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%
Enc Time	100%			100%		
Dec Time	101%			101%		

IBBB	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	0.0%	-0.1%	0.1%	0.0%	0.1%	-0.2%
Class C	0.0%	0.0%	0.3%	0.0%	-0.2%	-0.1%
Class D	-0.1%	0.3%	-0.1%	0.0%	0.4%	-0.3%
Class E	0.0%	-0.8%	0.3%	-0.2%	0.0%	-0.1%
All	0.0%	-0.1%	0.2%	0.0%	0.1%	-0.2%
Enc Time	100%			100%		
Dec Time	101%			100%		

Supplementary Result

- Intermediate result without DC prediction filtering harmonization

Intra	Intra			Intra LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.1%	0.0%	-0.1%	-0.1%	0.0%	-0.1%
Class B	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%
Class C	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%
Class D	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Class E	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
All	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%
Enc Time	100%			100%		
Dec Time	100%			100%		

HB7	Random access			Random access LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A	-0.1%	0.1%	-0.1%	0.0%	0.0%	0.0%
Class B	0.0%	-0.1%	-0.2%	0.0%	0.0%	0.0%
Class C	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%
Class D	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
Class E						
All	0.0%	0.1%	-0.1%	0.0%	0.0%	0.0%
Enc Time	100%			100%		
Dec Time	101%			101%		

IBBB	Low delay			Low delay LoCo		
	Y BD-rate	U BD-rate	V BD-rate	Y BD-rate	U BD-rate	V BD-rate
Class A						
Class B	0.0%	0.0%	-0.1%	0.0%	0.0%	-0.1%
Class C	0.0%	-0.1%	0.1%	0.0%	0.1%	-0.1%
Class D	0.0%	-0.3%	-0.4%	0.0%	0.3%	0.4%
Class E	0.2%	0.6%	1.3%	0.1%	0.7%	0.4%
All	0.0%	0.0%	0.1%	0.0%	0.3%	0.1%
Enc Time	100%			100%		
Dec Time	100%			100%		