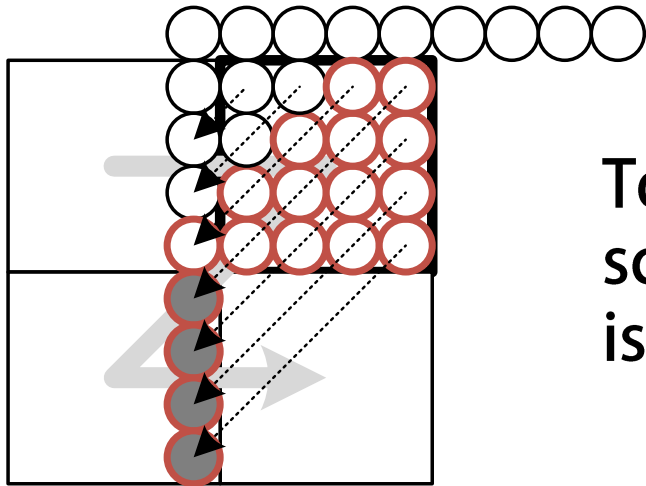


JVET-C0069: Direction-dependent scan order with JEM tools

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NHK

Introduction

In the 2nd JVET meeting, JVET-B0028 proposed direction-dependent scan order (DDSO)



To reduce inaccurate intra prediction, scan order depending on intra direction is proposed

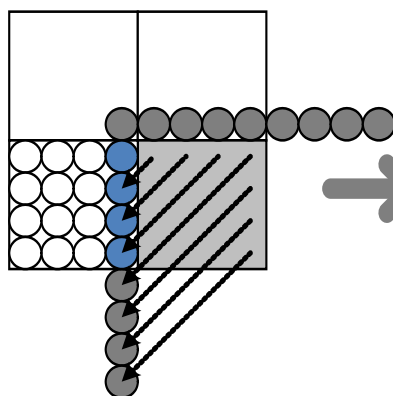
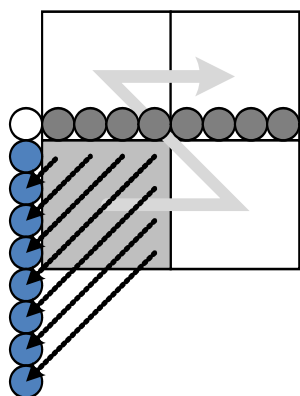
Inaccurate intra prediction

Overview of JVET-C0069

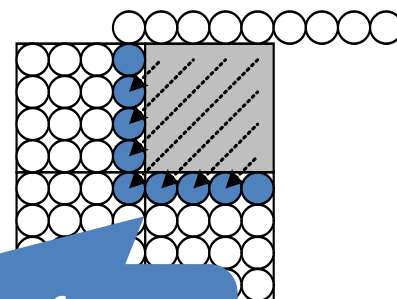
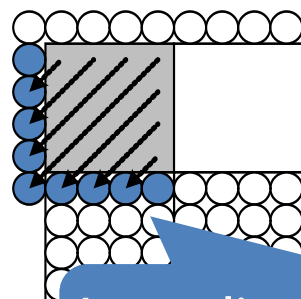
To propose improvement of DDSO with residual flipping.
To analyze interaction with intra-related JEM tools.

Review of DDSO

For intra prediction mode 2-17

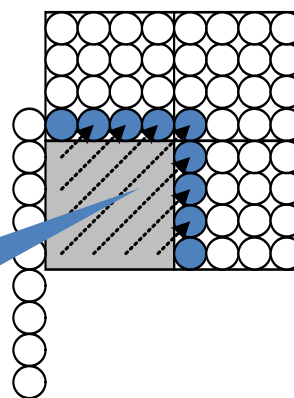
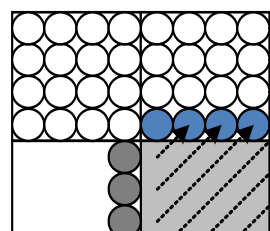
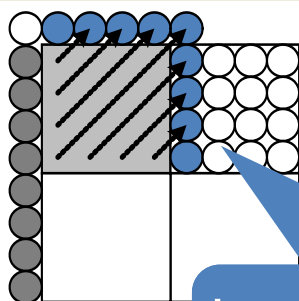
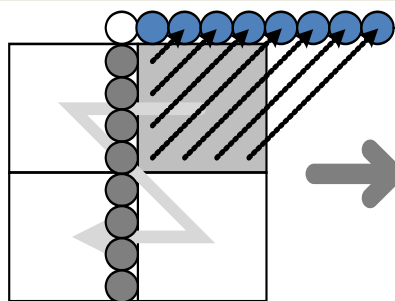


Vertically reverse



Immediately lower reference samples can be utilized •

For intra prediction mode 51-66



Horizontally reverse

Immediately right reference samples can be utilized •

• Referred "available" sample
• "Not available" sample

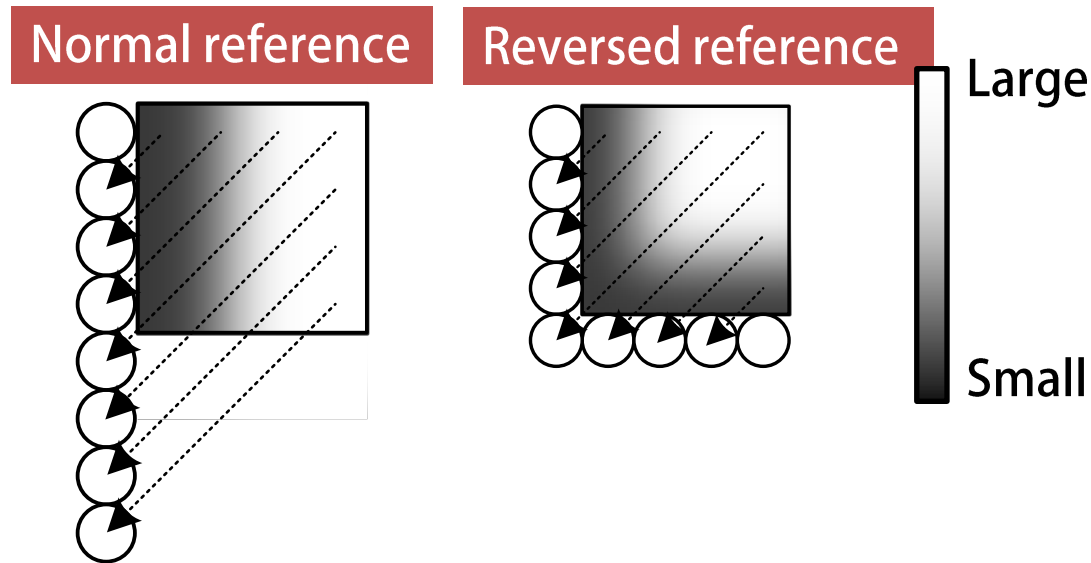
- Improving accuracy by using lower/right reference samples
- Semantics change, No additional syntax and encoder trial

Residual Flipping

The idea of the use of transformation which has asymmetric basis is coming from the fact that residual nearby reference samples is prone to be a small value.

Residual Statistics

When reference sample position is vertically or horizontally reversed, residual statistics are also changed.



If the reference position is reversed, residual is also reversed

Experimental Result

DDSO on top of HM16.6

Vs. HM16.6

	All Intra HE10			Random Access HE10		
	Y	U	V	Y	U	V
Class A	-0.23%	-0.47%	-0.38%	-0.10%	-0.21%	0.00%
Class B	-0.23%	-0.45%	-0.45%	-0.11%	-0.14%	-0.27%
Class C	-0.14%	-0.23%	-0.20%	-0.04%	0.04%	-0.13%
Class D	-0.08%	-0.15%	-0.17%	-0.04%	-0.13%	-0.20%
Class E	-0.28%	-0.47%	-0.54%	-0.17%	-0.44%	-0.41%
Overall	-0.19%	-0.35%	-0.34%	-0.09%	-0.16%	-0.20%
	-0.19%	-0.34%	-0.35%	-0.09%	-0.18%	-0.23%
Class F	-0.10%	-0.16%	-0.11%	-0.08%	-0.27%	-0.03%
Enc Time	104%			104%		
Dec Time	103%			100%		

Experimental Result

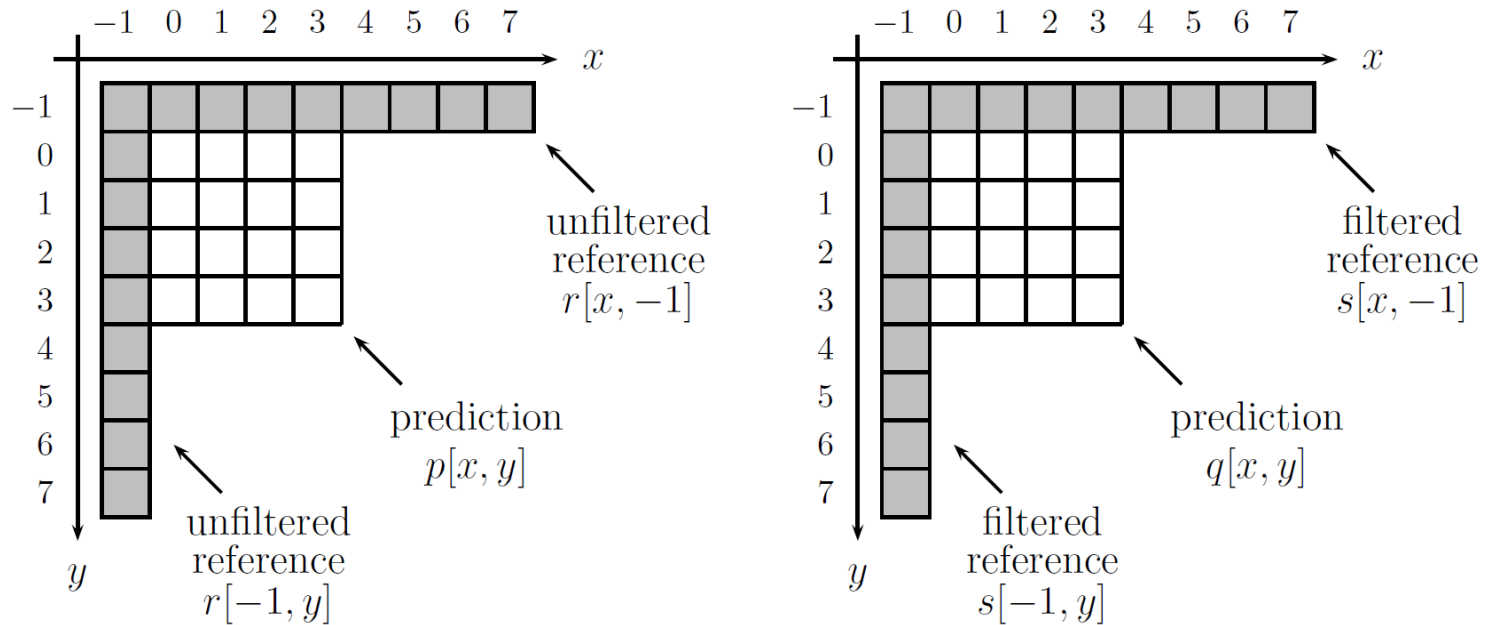
DDSO + Residual Flipping on top of HM16.6

Vs. HM16.6

	All Intra HE10			Random Access HE10		
	Y	U	V	Y	U	V
Class A	-0.27%	-0.54%	-0.39%	-0.14%	-0.12%	0.11%
Class B	-0.26%	-0.48%	-0.45%	-0.12%	-0.15%	-0.20%
Class C	-0.17%	-0.26%	-0.21%	-0.06%	-0.10%	-0.15%
Class D	-0.11%	-0.16%	-0.15%	-0.06%	0.16%	-0.23%
Class E	-0.35%	-0.50%	-0.63%	-0.24%	-0.52%	-0.48%
Overall	-0.23%	-0.39%	-0.36%	-0.12%	-0.13%	-0.18%
	-0.22%	-0.38%	-0.36%	-0.12%	-0.17%	-0.29%
Class F	-0.12%	-0.25%	-0.20%	-0.06%	-0.21%	-0.31%
Enc Time	104%			104%		
Dec Time	103%			101%		

Interaction with PDPC

Prediction is generated by combination of unfiltered and filtered reference

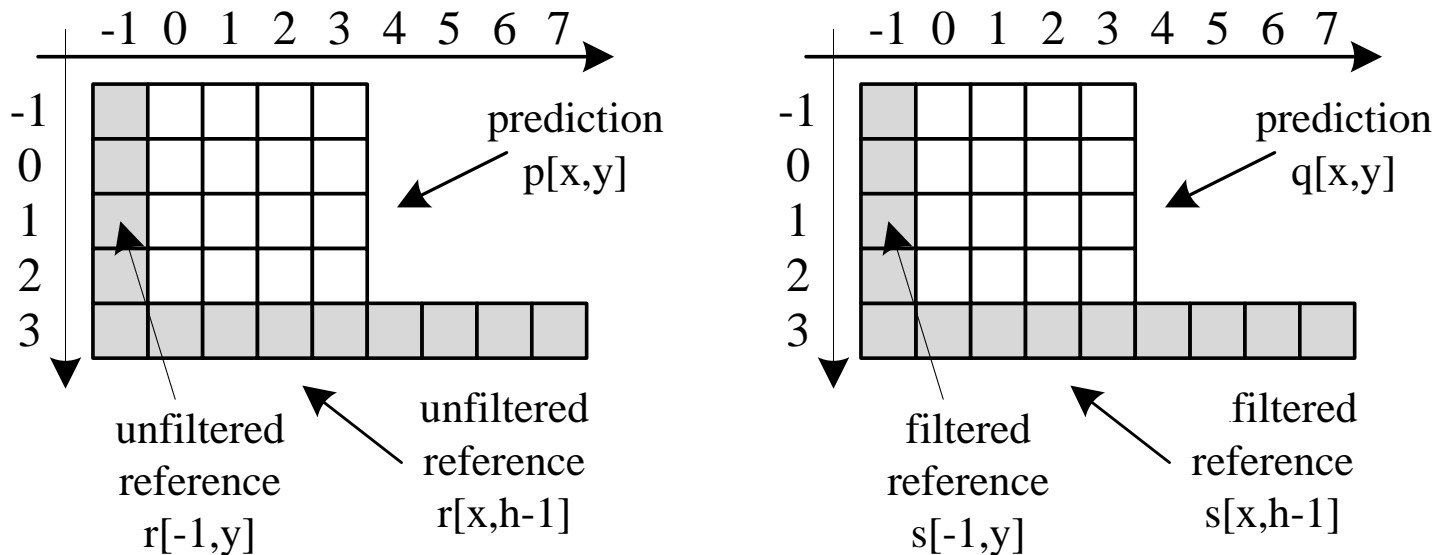


$$p[x, y] = \left\{ \left(c_1^{(v)} \gg \lfloor y/d \rfloor \right) r[x, -1] - \left(c_2^{(v)} \gg \lfloor y/d \rfloor \right) r[-1, -1] + \left(c_1^{(h)} \gg \lfloor x/d \rfloor \right) r[-1, y] - \left(c_2^{(h)} \gg \lfloor x/d \rfloor \right) r[-1, -1] + b[x, y] q[x, y] + 64 \right\} \gg 7$$

When DDSO is enable and reference position is changed, distance between reference and predicted sample is changed.

Harmonization with PDPC

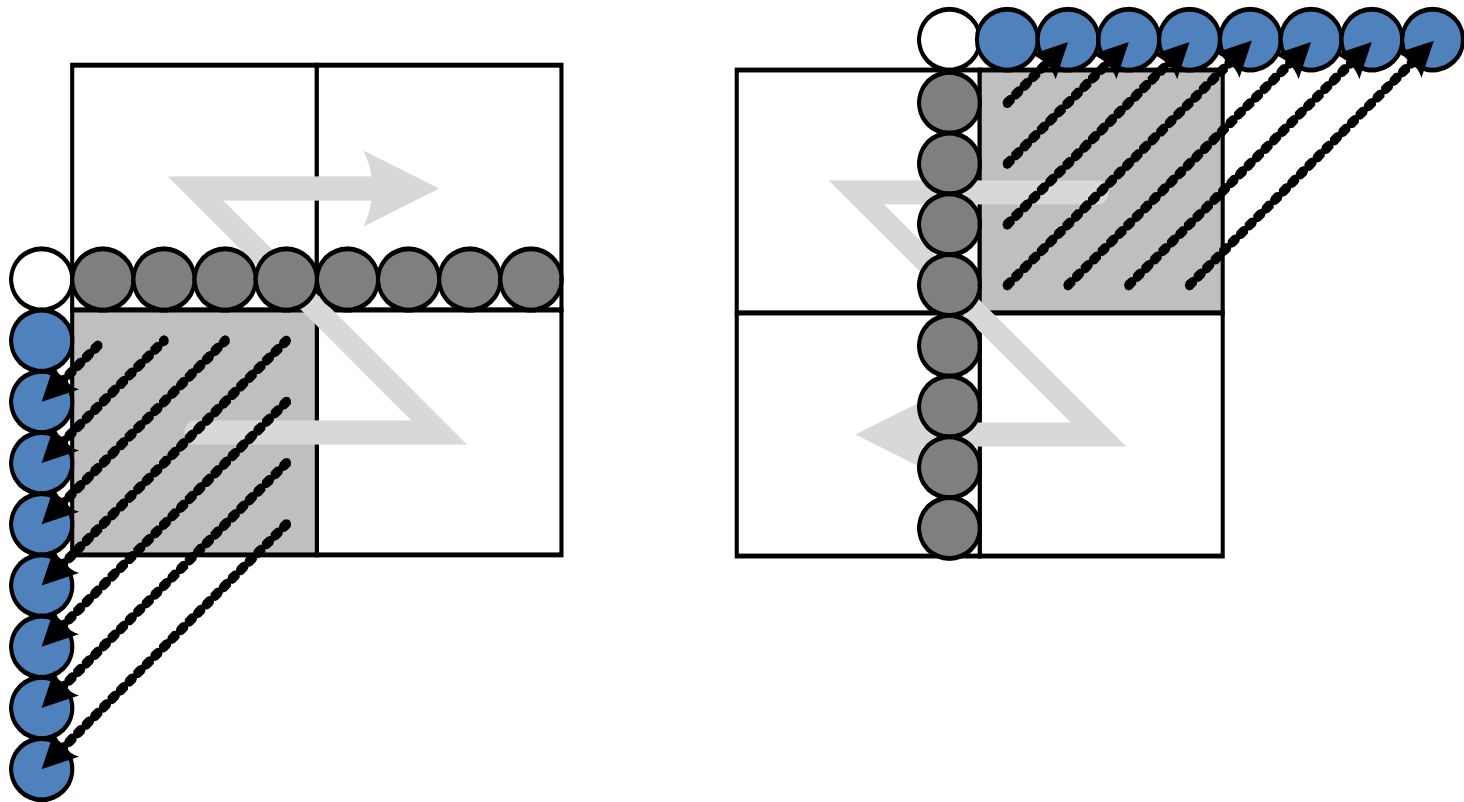
When reference sample position is changed by DDSO, computation of PDPC needs to be modified.



$$p[x, y] = \left\{ \left(c_1^{(v)} \gg \lfloor (h - y - 1) / d \rfloor \right) r[x, h - 1] - \left(c_2^{(v)} \gg \lfloor (h - y - 1) / d \rfloor \right) r[-1, h - 1] \right. \\ \left. + \left(c_1^{(h)} \gg \lfloor x / d \rfloor \right) r[-1, y] - \left(c_2^{(h)} \gg \lfloor x / d \rfloor \right) r[-1, h - 1] + b[x, y] q[x, y] \right\}$$

Interaction with Intra Boundary Filter

When the sub-TU scan order is vertically or horizontally reversed, the reference samples utilized for boundary filter may not be available



When DDSO is enable, Intra Boundary Filter is disabled

Experimental Result

DDSO+Residual Flipping+PDPC harm on top of JEM1.0-BF
Vs. JEM1.0-Intra Boundary Filter

	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-0.18%	-0.24%	-0.25%	105%	102%
Class C	-0.16%	-0.31%	-0.41%	103%	103%
Class D	-0.10%	-0.17%	-0.36%	104%	100%
Class E	-0.18%	-0.06%	-0.48%	102%	100%
Overall (Ref)	-0.16%	-0.21%	-0.36%	103%	101%
Class F	-0.13%	-0.34%	-0.32%	104%	103%

Experimental Result

DDSO+Residual Flipping+PDPC harm on top of JEM1.0-BF

Vs. JEM1.0

	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-0.04%	-0.10%	-0.08%	98%	87%
Class C	0.08%	0.11%	-0.04%	99%	90%
Class D	0.12%	0.20%	0.11%	100%	86%
Class E	-0.11%	0.06%	-0.16%	97%	84%
Overall (Ref)	0.02%	0.06%	-0.04%	99%	87%
Class F	-0.55%	-0.49%	-0.63%	98%	87%

Conclusion

- Direction-dependent scan order (DDSO) with residual flipping is proposed
- Minor change of PDPC to Harmonize with DDSO is proposed
- Intra boundary filter is disabled when DDSO is enable

Simulation results show comparable performance with 13% decoding time decrement on average.

Recommendation

- Encourage to study DDSO in EE