



CE8.c.2: Single-source SAO and ALF virtual boundary processing

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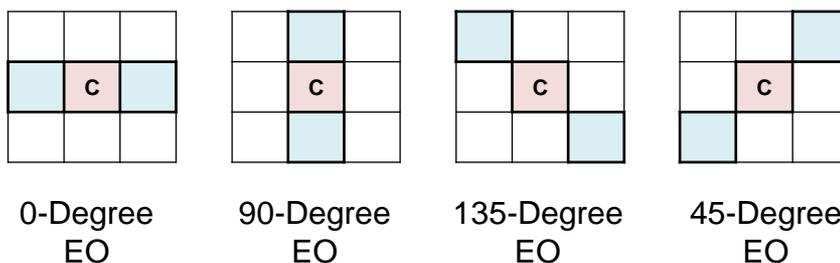
Presented by Yu-Wen Huang
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21-30 November, 2011

Overall Summary

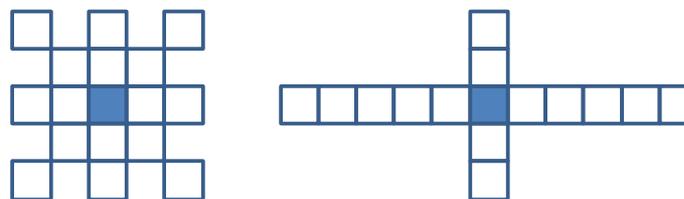
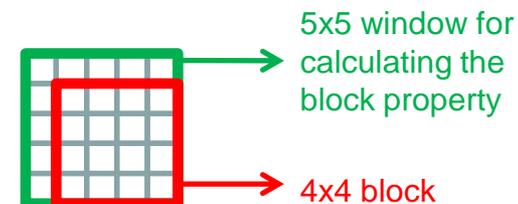
- In HM-4.0
 - SAO: 0.2 luma line, 0.2 chroma line
 - ALF: 4.1 luma lines, 4 chroma lines
- In the proposed virtual boundary (VB) processing
 - Luma VB: 4 pixels above the horizontal LCU boundary
 - Chroma VB: 2 pixels above the horizontal LCU boundary
 - Processing a pixel on one side of a VB does not use any pixel on the other side of the VB
 - Does not change SAO and ALF input pixels (single-source)
 - All SAO and ALF line buffers can be saved
 - 0.1-0.4% bit rate increase
 - No noticeable run time change
 - Slightly degraded visual quality

Background Information

- Deblocking filter (DF)
 - Luma: read 4 pixels and write 3 pixels
 - Chroma: read 2 pixels and write 1 pixel
- Sample adaptive offset (SAO)
 - Edge offset (EO): need a 3x3 window for pixel classification

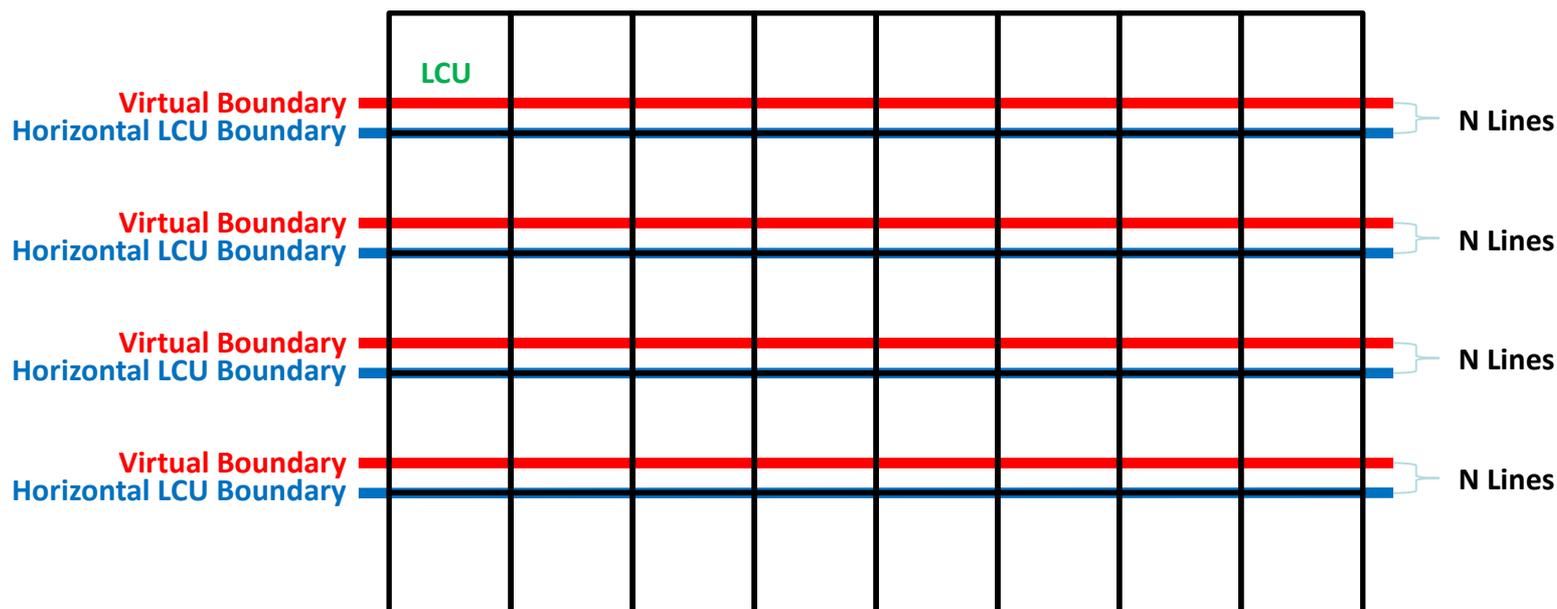


- Adaptive loop filter (ALF)
 - Calculate 4x4 block property for luma
 - Snowflake5x5
 - Cross11x5

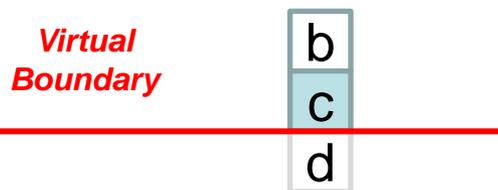


Virtual Boundary (VB)

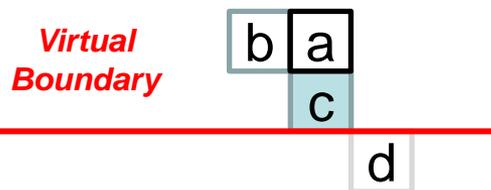
- $N=4$ for luma, $N=2$ for chroma
- Processing a pixel on one side of a VB does not use any pixel on the other side of the VB



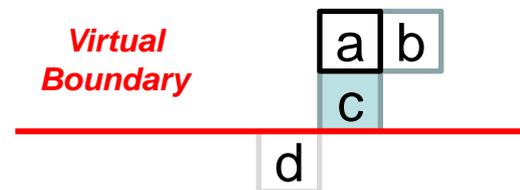
SAO VB Processing



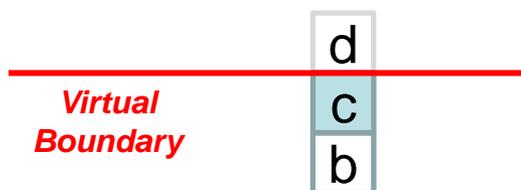
90-degree EO



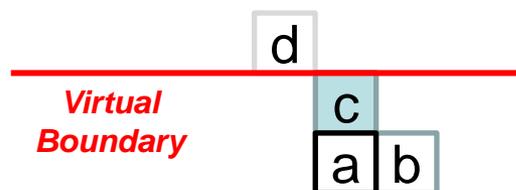
135-degree EO



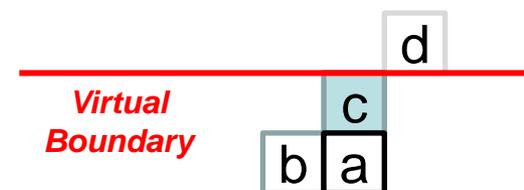
45-degree EO



90-degree EO



135-degree EO



45-degree EO

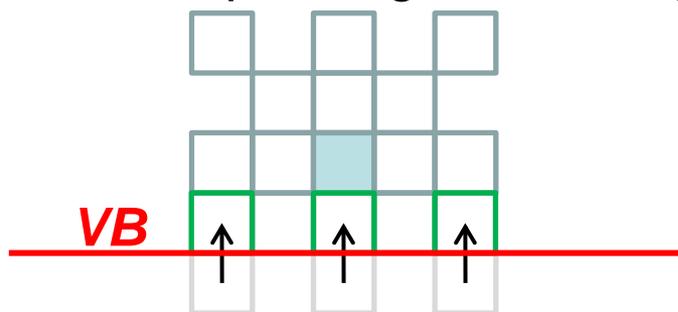
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if ( ( |c-a| < TH ) && (sanity check is passed) )
    c uses b's offset
else
    c uses zero offset
  
```

ALF VB Processing for Above-VB Pixels

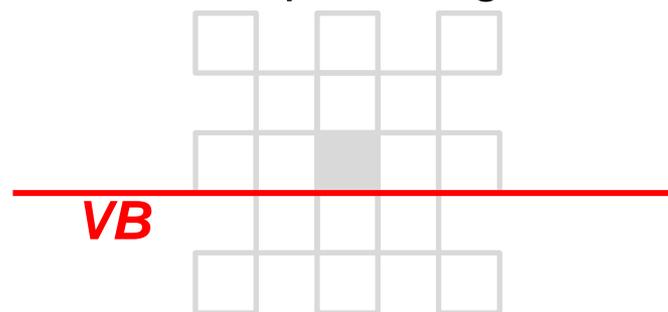
Snowflake5x5

2nd line: padding and averaging



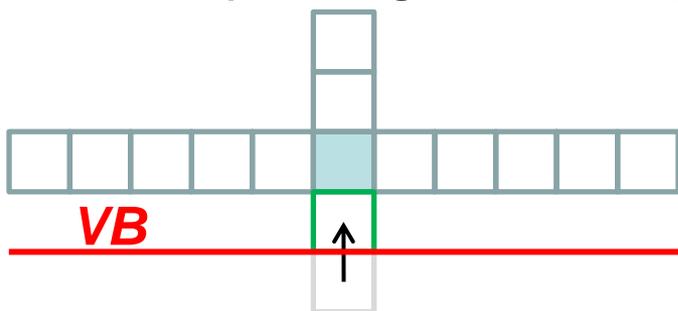
Snowflake5x5

1st line: skip filtering



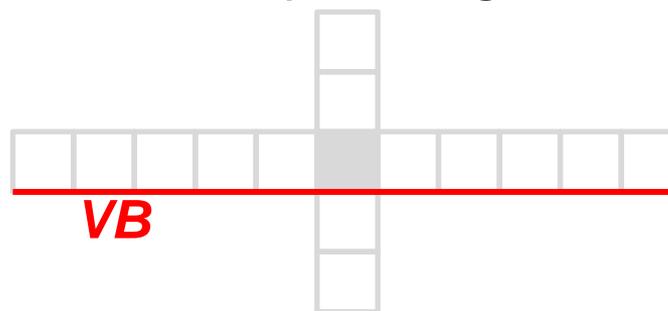
Cross11x5

2nd line: padding and averaging



Cross11x5

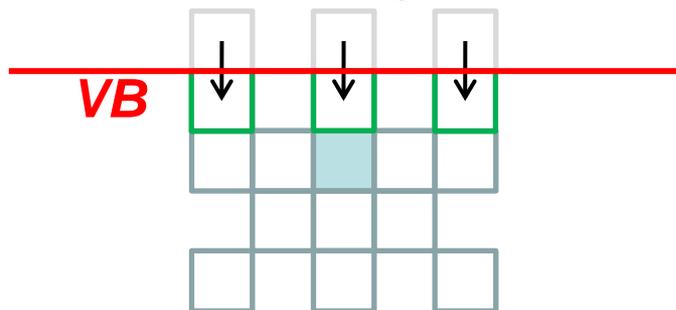
1st line: skip filtering



ALF VB Processing for Below-VB Pixels

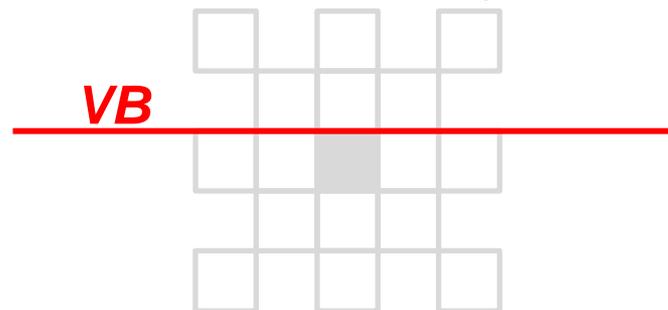
Snowflake5x5

2nd line: padding and averaging



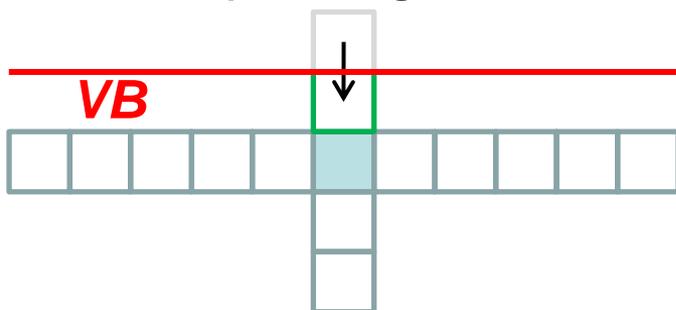
Snowflake5x5

1st line: skip filtering



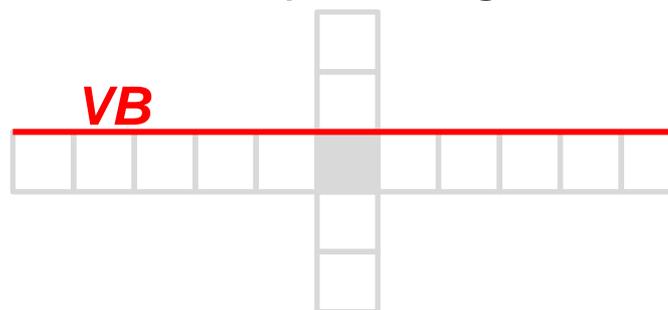
Cross11x5

2nd line: padding and averaging



Cross11x5

1st line: skip filtering



Simulation Results

- Anchor: JCTVC-F900
- 0.1-0.4% loss in HE
- 0.0-0.1% loss in LC
- Similar run times
- Slightly degraded visual quality in HE
- Same visual quality in LC

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.1%	0.2%	0.2%	0.0%	0.1%	0.2%
Class B	0.1%	0.2%	0.2%	0.0%	0.1%	0.1%
Class C	0.1%	0.3%	0.3%	0.0%	0.1%	0.1%
Class D	0.0%	0.2%	0.3%	0.0%	0.1%	0.1%
Class E	0.2%	0.4%	0.5%	0.0%	0.2%	0.1%
Overall	0.1%	0.3%	0.3%	0.0%	0.1%	0.1%
	0.1%	0.3%	0.3%	0.0%	0.1%	0.1%
Enc Time[%]	101%			99%		
Dec Time[%]	100%			100%		

	Random Access HE			Random Access LC		
	Y	U	V	Y	U	V
Class A	0.3%	0.6%	0.5%	0.1%	0.3%	0.3%
Class B	0.2%	0.5%	0.3%	0.0%	0.1%	0.2%
Class C	0.2%	0.3%	0.4%	0.1%	0.1%	0.1%
Class D	0.1%	0.3%	0.3%	0.0%	-0.1%	-0.1%
Class E						
Overall	0.2%	0.4%	0.4%	0.0%	0.1%	0.1%
	0.2%	0.4%	0.4%	0.0%	0.1%	0.1%
Enc Time[%]	101%			100%		
Dec Time[%]	100%			99%		

	Low Delay B HE			Low Delay B LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.2%	0.5%	0.4%	0.0%	0.3%	0.4%
Class C	0.2%	0.7%	0.5%	0.0%	0.4%	0.2%
Class D	0.1%	0.2%	0.8%	0.0%	0.0%	0.0%
Class E	0.7%	0.8%	1.8%	0.1%	1.5%	1.1%
Overall	0.3%	0.6%	0.8%	0.0%	0.5%	0.3%
	0.3%	0.5%	0.7%	0.0%	0.4%	0.3%
Enc Time[%]	98%			101%		
Dec Time[%]	98%			100%		

	Low Delay P HE			Low Delay P LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.4%	0.7%	0.7%	0.1%	0.4%	0.4%
Class C	0.2%	0.7%	0.6%	0.1%	0.3%	0.2%
Class D	0.2%	0.2%	0.5%	0.1%	0.1%	0.1%
Class E	0.9%	1.9%	1.3%	0.3%	0.6%	0.7%
Overall	0.4%	0.8%	0.7%	0.1%	0.3%	0.3%
	0.4%	0.8%	0.7%	0.1%	0.3%	0.3%
Enc Time[%]	99%			99%		
Dec Time[%]	99%			101%		

Conclusion

- Proposed virtual boundary processing for SAO and ALF
 - Remove all line buffers
 - 0.1-0.4% coding efficiency loss
 - Slightly degraded visual quality