



Non-SCE3.3: Modified Interlayer SAO with highpass processing

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Overall Summary

- **Objective**

Simplify the inter-layer SAO in SCE 3.3 for lowering complexity

- **Proposed Method**

Use the new sample classification method with highpass processing only for the horizontal and vertical classes

- **Average overall BD rate savings under the mandatory CTCs**

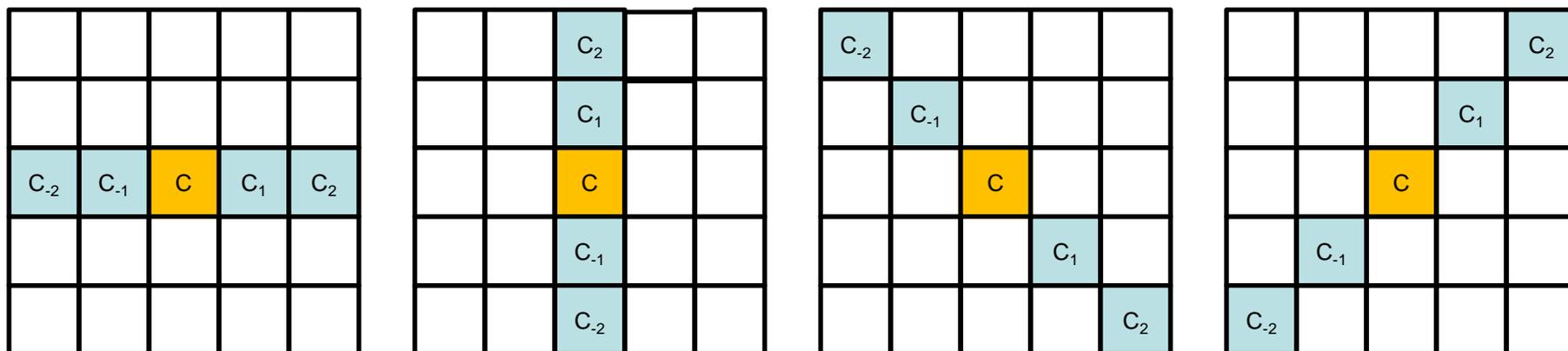
Y: 0.6 %, U: 0.7%, V: 0.8%

SCE3.3: Sample classification by highpass filtering (JCTVC-N0140)

- Category index determined by

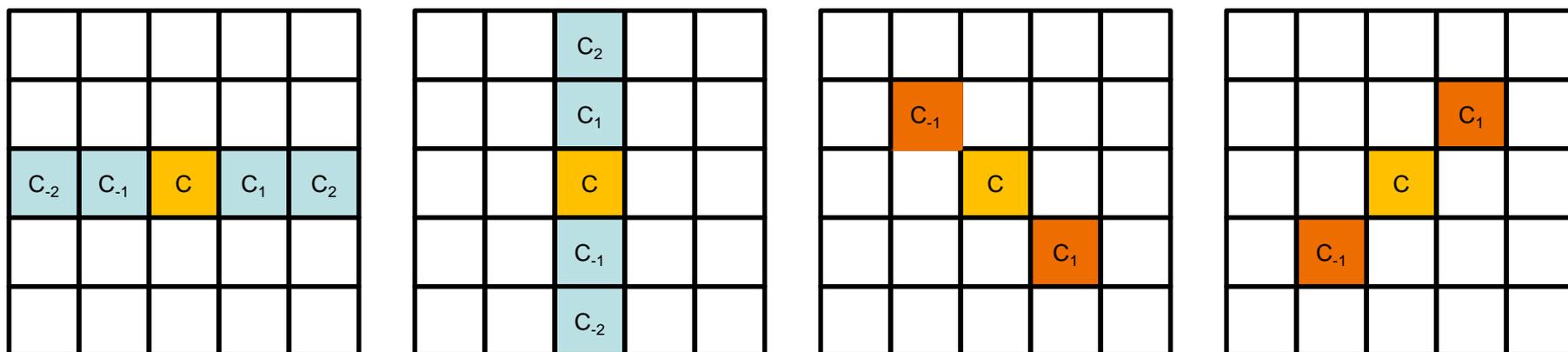
$$\text{cat_idx} = \text{sign}(((2 * c - c_{-1} - c_1 + 2) \gg 2) - ((2 * c_1 - c - c_2 + 2) \gg 2)) + \text{sign}(((2 * c - c_{-1} - c_1 + 2) \gg 2) - ((2 * c_{-1} - c_{-2} - c + 2) \gg 2)) + 2$$

- Processed by highpass filter $[-1, 2, -1]/4$ for sample classification
- Four neighboring pixels employed for sample classification
- SAO parameters coded by CABAC at the beginning of slice segment data



Proposed Method

- Use highpass processing for sample classification only for the horizontal and vertical classes
- Re-use the existing base-layer SAO module for processing the two diagonal EO classes
- Use VLC for coding SAO parameters in the slice segment header
- Benefits: saving additional memory access and processing for highpass filtering when the two diagonal EO classes are selected.



BD Rate Results under CTCs

	AI HEVC 2x			AI HEVC 1.5x		
	Y	U	V	Y	U	V
Class A	-1.0%	-1.4%	-1.5%			
Class B	-0.2%	-0.4%	-0.4%	-0.2%	-0.4%	-0.4%
Overall (Test vs Ref)	-0.4%	-0.7%	-0.7%	-0.2%	-0.4%	-0.4%
Overall (Test vs single layer)	12.3%	14.1%	13.8%	10.4%	9.4%	8.9%
EL only (Test vs Ref)	-0.9%	-1.2%	-1.2%	0.0%	-0.3%	-0.4%
Enc Time[%]		101.2%			101.1%	
Dec Time[%]		105.2%			105.1%	

	RA HEVC 2x			RA HEVC 1.5x			RA HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-1.1%	-0.8%	-1.2%				-2.3%	-1.6%	-2.0%
Class B	-0.3%	-0.4%	-0.4%	-0.2%	-0.4%	-0.4%	-0.9%	-0.8%	-0.6%
Overall (Test vs Ref)	-0.5%	-0.5%	-0.6%	-0.2%	-0.4%	-0.4%	-1.3%	-1.0%	-1.0%
Overall (Test vs single layer)	18.6%	32.6%	31.2%	15.9%	28.4%	28.6%	12.9%	30.8%	32.8%
EL only (Test vs Ref)	-0.9%	-0.9%	-1.0%	-0.2%	-0.4%	-0.5%	-2.0%	-1.7%	-1.7%
Enc Time[%]		99.9%			99.7%			99.8%	
Dec Time[%]		106.2%			103.4%			110.0%	

	LD-B HEVC 2x			LD-B HEVC 1.5x			LD-B HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-1.0%	-0.9%	-1.3%				-2.0%	-1.6%	-2.1%
Class B	-0.4%	-0.7%	-0.6%	-0.3%	-0.8%	-1.0%	-0.8%	-1.1%	-1.1%
Overall (Test vs Ref)	-0.5%	-0.8%	-0.8%	-0.3%	-0.8%	-1.0%	-1.1%	-1.2%	-1.4%
Overall (Test vs single layer)	27.8%	38.0%	38.7%	24.4%	32.1%	34.7%	22.9%	33.1%	37.6%
EL only (Test vs Ref)	-0.9%	-1.1%	-1.2%	-0.2%	-0.7%	-0.9%	-1.6%	-1.8%	-1.9%
Enc Time[%]		99.8%			100.3%			100.6%	
Dec Time[%]		110.2%			108.2%			111.3%	

	LD-P HEVC 2x			LD-P HEVC 1.5x			LD-P HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-1.1%	-1.2%	-1.6%				-3.3%	-2.3%	-2.5%
Class B	-0.5%	-1.1%	-0.9%	-0.7%	-1.4%	-1.2%	-1.7%	-1.6%	-1.5%
Overall (Test vs Ref)	-0.7%	-1.1%	-1.1%	-0.7%	-1.4%	-1.2%	-2.1%	-1.8%	-1.8%
Overall (Test vs single layer)	25.7%	36.6%	37.7%	22.0%	31.1%	34.1%	20.7%	32.3%	37.0%
EL only (Test vs Ref)	-1.2%	-1.5%	-1.6%	-0.7%	-1.5%	-1.3%	-3.1%	-2.7%	-2.7%
Enc Time[%]		99.7%			99.7%			99.8%	
Dec Time[%]		109.0%			108.6%			114.8%	

* Thank Samsung for the cross check (JCTVC-N0307)

Overall BD Rate Comparison with SCE3.3 (JCTVC-N0140)

	SCE3.3 (N0140)			Proposal		
	Y	U	V	Y	U	V
AI HEVC 2x	-0.4%	-0.6%	-0.6%	-0.4%	-0.7%	-0.7%
AI HEVC 1.5x	-0.2%	-0.4%	-0.5%	-0.2%	-0.4%	-0.4%
RA HEVC 2x	-0.5%	-0.3%	-0.4%	-0.5%	-0.5%	-0.6%
RA HEVC 1.5x	-0.3%	-0.4%	-0.3%	-0.2%	-0.4%	-0.4%
RA HEVC SNR	-1.4%	-1.1%	-1.0%	-1.3%	-1.0%	-1.0%
LD-B HEVC 2x	-0.5%	-0.3%	-0.3%	-0.5%	-0.8%	-0.8%
LD-B HEVC 1.5x	-0.4%	-0.4%	-0.4%	-0.3%	-0.8%	-1.0%
LD-B HEVC SNR	-1.2%	-1.1%	-1.1%	-1.1%	-1.2%	-1.4%
Average	-0.6%	-0.6%	-0.6%	-0.6%	-0.7%	-0.8%

Conclusion

- Proposed to simplify the inter-layer SAO in SCE 3.3 (JCTVC-N0140) for reduced complexity
- Overall average YUV BD rate improvements

EL+BL	AI 2x	AI 1.5X	RA 2x	RA 1.5x	RA SNR	LD-P 2x	LD-P 1.5x	LD-P SNR	LD-B 2x	LD-B 1.5x	LD-B SNR
Class A	-1.1%		-1.0%		-2.2%	-1.2%		-3.2%	-1.0%		-2.0%
Class B	-0.2%	-0.2%	-0.3%	-0.3%	-0.9%	-0.6%	-0.8%	-1.7%	-0.4%	-0.4%	-0.9%
Overall (Test vs Ref)	-0.5%	-0.2%	-0.5%	-0.3%	-1.3%	-0.8%	-0.8%	-2.1%	-0.6%	-0.4%	-1.2%
EL only (Test vs Ref)	-0.9%	-0.1%	-0.9%	-0.3%	-2.0%	-1.2%	-0.9%	-3.0%	-1.0%	-0.3%	-1.7%

- No performance loss compared with the inter-layer SAO in SCE 3.3