


Non-SCE3.3: Inter-layer interpolation-based SAO filtering for SHVC



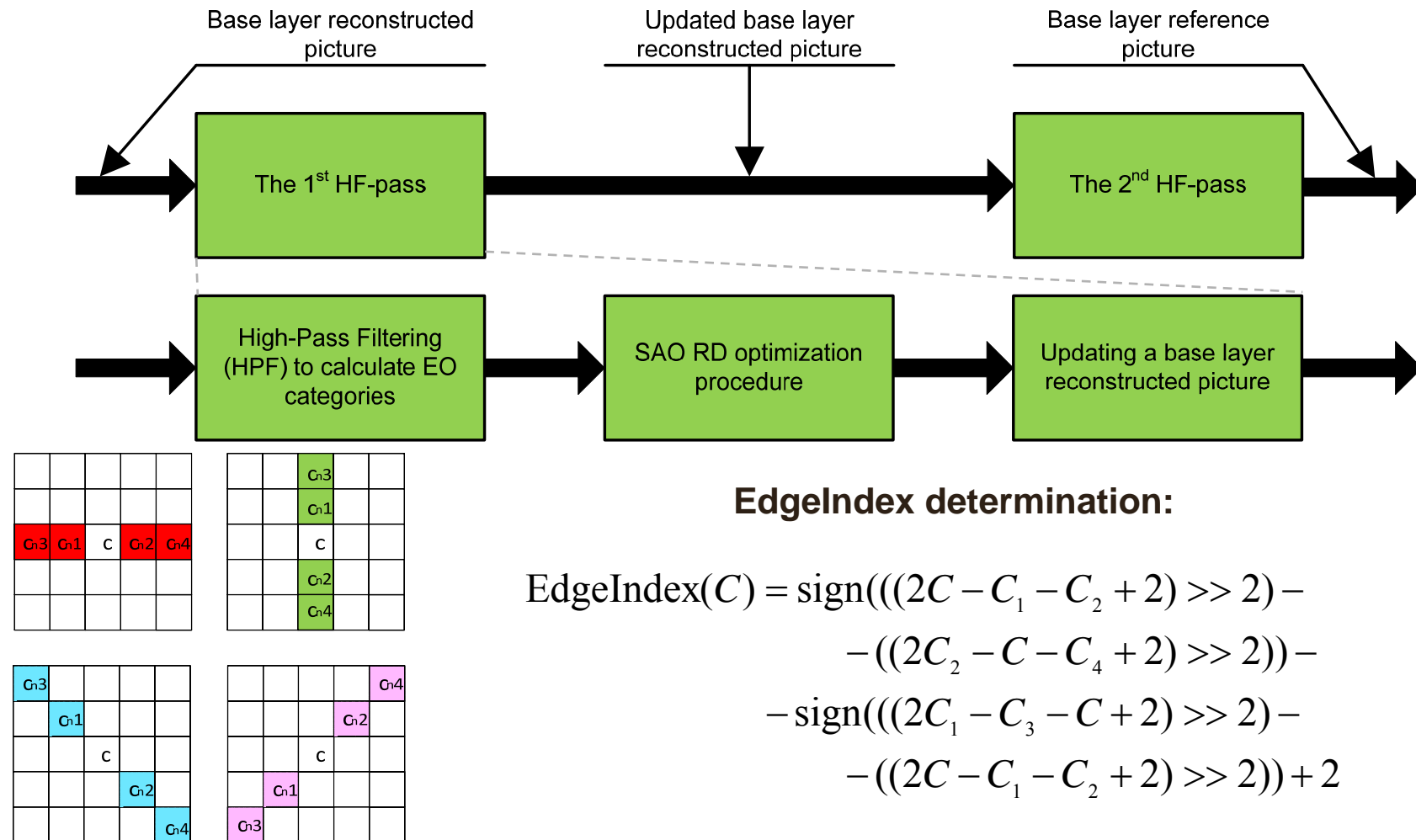
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SCE3.3: HF-IL-SAO (High-Frequency pass Inter-Layer Sample Adaptive Offset) filtering

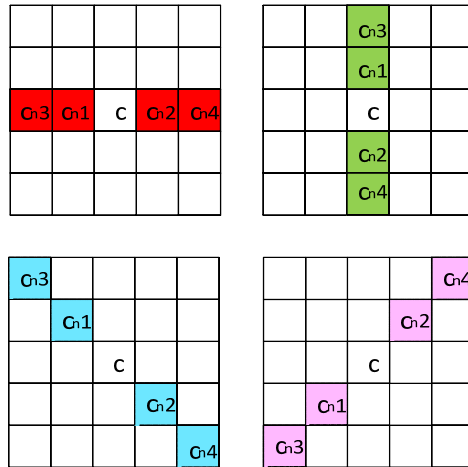
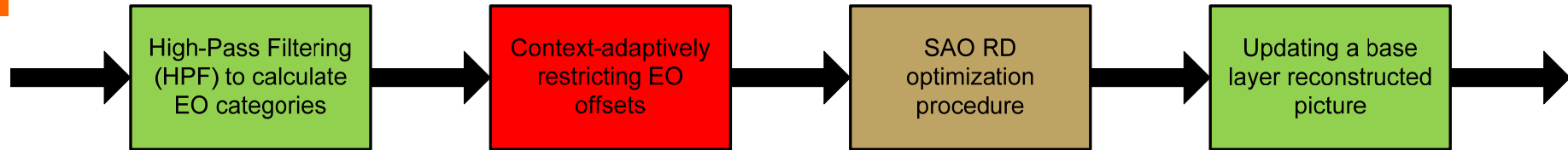
Data-flow chart of HF-IL-SAO filtering based on proposal JCTVC-M0114



$$\begin{aligned} \text{EdgeIndex}(C) = & \text{sign}(((2C - C_1 - C_2 + 2) \gg 2) - \\ & - ((2C_2 - C - C_4 + 2) \gg 2)) - \\ & - \text{sign}(((2C_1 - C_3 - C + 2) \gg 2) - \\ & - ((2C - C_1 - C_2 + 2) \gg 2)) + 2 \end{aligned}$$

HF-IL-iSAO (interpolation-based SAO) filtering

Modified HF pass data-flow chart



Context-adaptive restriction of a pixel value after SAO filtering:

$$C_{\max} = \frac{(2^{n-1} + 1)(C_1 + C_2) - (C_3 + C_4)}{2^n} =$$

$$= (((C_1 + C_2) \ll (n-1)) + (C_1 + C_2) - (C_3 + C_4)) \gg n, n = 3$$

The EO offsets for different categories:

Categories 1 and 2:

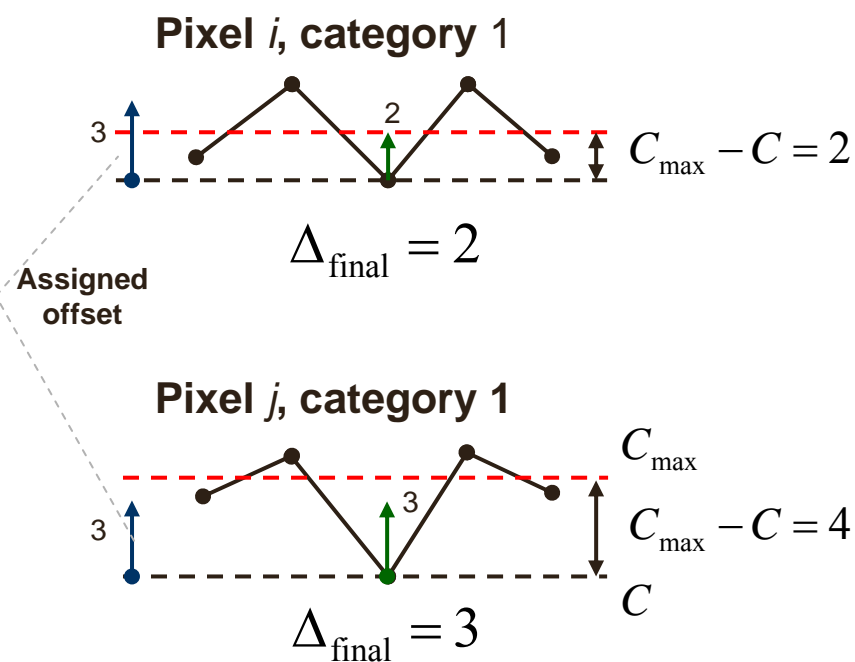
$$\Delta_{\text{final}} = \begin{cases} \Delta, & \text{if } (C_{\max} > C) \& \& (C + \Delta \leq C_{\max}) \\ (C_{\max} - C), & \text{if } (C_{\max} > C) \& \& \\ & \& \& (C + \Delta > C_{\max}) \\ 0, & \text{otherwise} \end{cases}$$

Categories 3 and 4:

$$\Delta_{\text{final}} = \begin{cases} \Delta, & \text{if } (C_{\max} < C) \& \& (C + \Delta \geq C_{\max}) \\ (C - C_{\max}), & \text{if } (C_{\max} < C) \& \& \\ & \& \& (C + \Delta < C_{\max}) \\ 0, & \text{otherwise} \end{cases}$$

An example of context-adaptive restrictions for EO offsets

edgeIndex	Category	Offset
0	1	3
1	2	4
3	3	-4
4	4	-5



Experiments Results - RefIdx

– Reference: SHM2.0

	AI HEVC 2x			AI HEVC 1.5x		
	Y	U	V	Y	U	V
Class A	-1,0%	-1,3%	-1,3%			
Class B	-0,2%	-0,3%	-0,3%	-0,3%	-0,4%	-0,5%
Overall (Test vs Ref)	-0,5%	-0,6%	-0,6%	-0,3%	-0,4%	-0,5%
Overall (Test vs single layer)	12,3%	14,2%	13,9%	10,3%	9,3%	8,8%
Overall (Ref vs single layer)	12,8%	14,9%	14,6%	10,5%	9,8%	9,3%
EL only (Test vs Ref)	-0,9%	-1,0%	-1,0%	-0,1%	-0,4%	-0,4%
BL Match	Matched			Matched		

	RA HEVC 2x			RA HEVC 1.5x			RA HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-1,0%	-0,7%	-0,7%				-2,5%	-1,8%	-2,0%
Class B	-0,4%	-0,3%	-0,2%	-0,3%	-0,4%	-0,3%	-1,1%	-0,8%	-0,6%
Overall (Test vs Ref)	-0,5%	-0,4%	-0,4%	-0,3%	-0,4%	-0,3%	-1,5%	-1,0%	-1,0%
Overall (Test vs single layer)	18,6%	32,8%	31,5%	15,8%	28,4%	28,7%	12,7%	30,8%	32,8%
Overall (Ref vs single layer)	19,2%	33,3%	32,0%	16,2%	28,8%	29,1%	14,4%	32,1%	34,1%
EL only (Test vs Ref)	-0,9%	-0,8%	-0,8%	-0,3%	-0,3%	-0,3%	-2,3%	-1,8%	-1,8%
BL Match	Matched			Matched			Matched		

	LD-B HEVC 2x			LD-B HEVC 1.5x			LD-B HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-0,9%	-0,7%	-0,6%				-2,2%	-1,5%	-1,9%
Class B	-0,4%	-0,3%	-0,2%	-0,4%	-0,4%	-0,4%	-0,9%	-1,0%	-0,8%
Overall (Test vs Ref)	-0,6%	-0,4%	-0,4%	-0,4%	-0,4%	-0,4%	-1,3%	-1,2%	-1,1%
Overall (Test vs single layer)	27,8%	38,4%	39,3%	24,3%	32,5%	35,4%	22,7%	33,2%	38,0%
Overall (Ref vs single layer)	28,5%	39,0%	39,7%	24,8%	33,0%	35,9%	24,3%	34,7%	39,5%
EL only (Test vs Ref)	-0,9%	-0,8%	-0,7%	-0,2%	-0,3%	-0,3%	-1,9%	-1,7%	-1,7%
BL Match	Matched			Matched			Matched		

Optional Tests

	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%	-0,8%	-0,8%				-4,0%	-2,4%	-2,6%
Class B	-1,0%	-0,7%	-0,7%	-1,1%	-0,9%	-0,9%	-2,2%	-1,5%	-1,3%
Overall (Test vs Ref)	-1,0%	-0,7%	-0,7%	-1,1%	-0,9%	-0,9%	-2,7%	-1,8%	-1,7%
Overall (Test vs single layer)	25,3%	37,1%	38,1%	21,5%	31,7%	34,5%	20,1%	32,3%	37,2%
Overall (Ref vs single layer)	26,6%	38,0%	39,1%	22,8%	32,8%	35,6%	23,4%	34,6%	39,4%
EL only (Test vs Ref)	-1,5%	-1,2%	-1,3%	-1,1%	-0,9%	-0,9%	-3,8%	-2,8%	-2,7%
BL Match	Matched			Matched			Matched		

Preliminary Results of Complexity Analysis - RefIdx

- Reference: SHM2.0
- Short length: first 32 frames of every test sequence
- The implementation is not optimized and could be considerably improved

	AI HEVC 2x	AI HEVC 1.5x
Enc Time[%]	106,5%	106,8%
Dec Time[%]	126,6%	134,2%

	RA HEVC 2x	RA HEVC 1.5x	RA HEVC SNR
Enc Time[%]	102,2%	101,9%	102,1%
Dec Time[%]	132,6%	127,9%	142,3%

Optional Tests

	LD-P HEVC 2x	LD-P HEVC 1.5x
Enc Time[%]	101,7%	102,0%
Dec Time[%]	136,4%	141,4%

Conclusions

- The average values of the BD-rate reductions for different configurations for the proposed modifications compared to SHM2.0 are presented in the following table:

Configuration	BDR reduction for different color planes, %		
	Y	U	V
The average value for the mandatory tests	0.7	0.6	0.6
The average value for the mandatory and optional tests	0.9	0.8	0.7
SNR configuration	1.8	1.3	1.3

- The complexity analysis results are very preliminary. The further reduction of computational complexity is possible for both the encoder and the decoder by optimizing the current software solution and introducing look-up tables
- According to these results, we recommend to include this modification of inter-layer SAO filter into an SHVC Core Experiment.

Thank You

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