



MEDIATEK

JVET-K0233

**Sample adaptive offset with EO sign constraints
removal and more EO patterns**

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Overall Summary

- Two SAO modifications
 - Test1: Remove edge offset (EO) sign constraints
 - Test2: Add three 2D EO patterns
- Experimental results

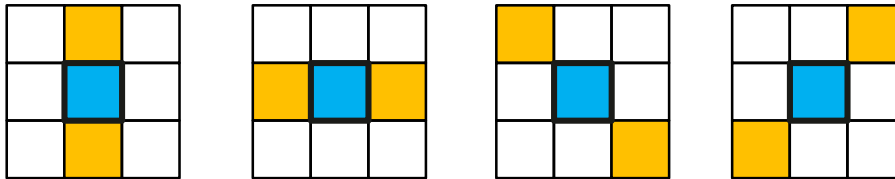
Compared to SAO On		VTM-1.0			BMS-1.0		
		Y	U	V	Y	U	V
Test1	AI	0.00%	0.03%	0.03%	0.00%	-0.01%	-0.07%
	RA	-0.04%	-0.10%	-0.07%	0.02%	-0.08%	-0.06%
	LB	-0.17%	0.06%	-0.04%	-0.07%	-0.07%	-0.04%
Test1 + Test2	AI	-0.04%	-0.06%	-0.07%	-0.03%	-0.03%	-0.12%
	RA	-0.13%	-0.21%	-0.11%	-0.03%	-0.24%	-0.17%
	LB	-0.15%	-0.32%	-0.21%	-0.14%	-0.57%	-0.30%

Proposed Method (Test1)

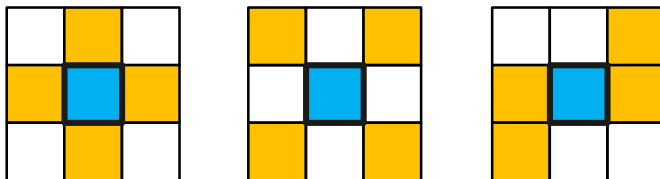
- In VTM-1.0, the signs of EO are regularized as HEVC to allow smoothing only
 - For samples with values larger than neighbors, only negative offsets are allowed.
 - For samples with values smaller than neighbors, only positive offsets are allowed.
- Propose to signal the signs of offsets in EO to the decoder
 - Allow performing both smoothing and sharpening
 - The selection between smoothing and sharpening is made at encoder

Proposed Method (Test2)

- In VTM-1.0, there are four 1D EO patterns.



- Propose to add three 2D EO patterns
 - Classify samples into five categories, same as 1D EO patterns
 - Use three bins to indicate the selection among four 1D EO patterns, three 2D EO patterns, and one BO mode



Simulation Results

- Implemented on top of BMS-1.0
 - Test1: Remove EO sign constraints
 - Test2: Add three 2D EO patterns
- No noticeable encoding time and decoding time increases

Compared to SAO On		VTM-1.0			BMS-1.0		
		Y	U	V	Y	U	V
Test1	AI	0.00%	0.03%	0.03%	0.00%	-0.01%	-0.07%
	RA	-0.04%	-0.10%	-0.07%	0.02%	-0.08%	-0.06%
	LB	-0.17%	0.06%	-0.04%	-0.07%	-0.07%	-0.04%
Test1 + Test2	AI	-0.04%	-0.06%	-0.07%	-0.03%	-0.03%	-0.12%
	RA	-0.13%	-0.21%	-0.11%	-0.03%	-0.24%	-0.17%
	LB	-0.15%	-0.32%	-0.21%	-0.14%	-0.57%	-0.30%

Conclusions

- Proposed two SAO modifications including removing EO sign constraints and adding three 2D EO patterns
- Experimental results
 - Removing EO sign constraints achieves 0.00%, -0.04%, and -0.17% luma BD-rates for AI, RA, and LB on VTM-1.0, and 0.00%, 0.02%, and -0.07% luma BD-rates for AI, RA, and LB on BMS-1.0.
 - Adding 3 2D EO patterns additionally provides -0.04%, -0.21%, and -0.12% BD-rates for Y, U, and V, respectively.
- Thank Qualcomm for cross-checking.



BQMall QP37 in VTM-1.0-LB 101th Picture

Uncompressed



VTM-1.0

VTM-1.0 with
Test1

Simulation Results

- Test1: Remove edge offset (EO) sign constraints
- Test2: Add 3 2D EO patterns

Compared to SAO Off		VTM-1.0			BMS-1.0		
		Y	U	V	Y	U	V
SAO On	AI	-0.44%	-1.61%	-2.15%	-0.13%	-1.81%	-2.30%
	RA	-1.30%	-1.94%	-1.97%	-0.59%	-1.97%	-2.11%
	LB	-1.12%	-3.99%	-5.72%	-1.09%	-3.96%	-5.87%
SAO On + Test1	AI	-0.44%	-1.59%	-2.12%	-0.13%	-1.81%	-2.36%
	RA	-1.34%	-2.04%	-2.04%	-0.57%	-2.05%	-2.17%
	LB	-1.29%	-3.92%	-5.75%	-1.16%	-4.03%	-5.88%
SAO On + Test1 + Test2	AI	-0.48%	-1.67%	-2.22%	-0.16%	-1.84%	-2.41%
	RA	-1.42%	-2.14%	-2.07%	-0.63%	-2.20%	-2.28%
	LB	-1.27%	-4.30%	-5.92%	-1.23%	-4.52%	-6.15%

Simulation Results of Test1

	All Intra Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	0.01%	0.02%	0.03%	100%	100%	0.00%	-0.01%	-0.18%	99%	99%
Class A2	0.00%	0.03%	0.01%	100%	100%	0.00%	0.01%	-0.06%	100%	100%
Class B	0.00%	0.01%	0.02%	99%	100%	0.01%	-0.04%	-0.11%	99%	100%
Class C	0.01%	0.02%	0.03%	100%	100%	0.01%	0.00%	0.01%	99%	100%
Class E	-0.04%	0.06%	0.09%	100%	100%	-0.01%	0.02%	-0.01%	100%	100%
Overall	0.00%	0.03%	0.03%	100%	100%	0.00%	-0.01%	-0.07%	100%	100%
Class D	0.01%	0.03%	0.07%	100%	99%	0.01%	0.01%	0.04%	100%	100%
Class F (optional)	0.00%	0.01%	0.01%	100%	100%	0.01%	0.04%	0.00%	100%	100%
	Random Access Main 10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.01%	0.01%	0.06%	99%	103%	0.01%	-0.18%	0.00%	100%	99%
Class A2	-0.08%	-0.12%	-0.24%	99%	101%	0.02%	-0.02%	-0.06%	100%	101%
Class B	-0.03%	-0.16%	-0.03%	100%	101%	-0.01%	-0.08%	-0.17%	100%	101%
Class C	-0.05%	-0.09%	-0.09%	100%	101%	0.06%	-0.05%	0.04%	100%	100%
Class E										
Overall	-0.04%	-0.10%	-0.07%	100%	101%	0.02%	-0.08%	-0.06%	100%	100%
Class D	-0.07%	-0.01%	0.01%	100%	101%	0.06%	0.13%	0.20%	100%	100%
Class F (optional)	0.01%	-0.02%	-0.03%	99%	99%	0.04%	0.07%	-0.02%	100%	100%
	Low delay B Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1										
Class A2										
Class B	-0.12%	-0.02%	0.03%	100%	100%	-0.01%	-0.27%	-0.25%	100%	100%
Class C	-0.02%	-0.06%	-0.11%	100%	99%	-0.02%	0.04%	0.07%	100%	100%
Class E	-0.47%	0.36%	-0.07%	99%	99%	-0.23%	0.12%	0.18%	100%	100%
Overall	-0.17%	0.06%	-0.04%	100%	99%	-0.07%	-0.07%	-0.04%	100%	100%
Class D	-0.05%	0.00%	0.13%	100%	100%	0.02%	0.76%	-0.24%	100%	100%
Class F (optional)	-0.08%	-0.14%	-0.08%	100%	101%	0.06%	0.12%	-0.05%	100%	99%

Simulation Results of Test2

	All Intra Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.03%	-0.08%	-0.08%	101%	101%	0.00%	-0.21%	-0.46%	100%	100%
Class A2	-0.04%	-0.02%	-0.03%	101%	100%	-0.02%	0.02%	-0.09%	100%	100%
Class B	-0.03%	-0.03%	-0.05%	101%	100%	-0.01%	-0.02%	-0.17%	100%	100%
Class C	-0.03%	-0.07%	-0.08%	101%	100%	-0.04%	-0.05%	-0.01%	100%	100%
Class E	-0.09%	-0.11%	-0.12%	101%	100%	-0.06%	0.08%	0.14%	100%	100%
Overall	-0.04%	-0.06%	-0.07%	101%	100%	-0.03%	-0.03%	-0.12%	100%	100%
Class D	0.00%	-0.05%	-0.11%	101%	100%	0.00%	0.00%	0.01%	101%	101%
Class F (optional)	-0.01%	-0.01%	0.01%	101%	100%	-0.05%	0.06%	0.08%	100%	100%
	Random Access Main 10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.12%	-0.15%	-0.08%	99%	100%	0.00%	-0.50%	-0.03%	100%	99%
Class A2	-0.21%	-0.21%	-0.23%	99%	102%	-0.04%	-0.09%	-0.20%	100%	100%
Class B	-0.13%	-0.29%	-0.06%	100%	100%	-0.07%	-0.22%	-0.27%	100%	101%
Class C	-0.07%	-0.14%	-0.10%	100%	101%	-0.01%	-0.17%	-0.13%	100%	99%
Class E										
Overall	-0.13%	-0.21%	-0.11%	100%	100%	-0.03%	-0.24%	-0.17%	100%	100%
Class D	-0.05%	0.07%	0.02%	100%	101%	0.06%	-0.06%	-0.03%	101%	100%
Class F (optional)	0.01%	0.00%	-0.02%	100%	100%	-0.01%	-0.05%	-0.09%	100%	100%
	Low delay B Main10									
	Over VTM-1.0					Over BMS-1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1										
Class A2										
Class B	-0.15%	-0.36%	-0.27%	100%	101%	-0.06%	-0.75%	-0.45%	101%	100%
Class C	0.00%	-0.48%	-0.06%	100%	100%	-0.05%	-0.35%	-0.35%	101%	100%
Class E	-0.37%	-0.03%	-0.32%	100%	100%	-0.41%	-0.58%	0.02%	101%	100%
Overall	-0.15%	-0.32%	-0.21%	100%	100%	-0.14%	-0.57%	-0.30%	101%	100%
Class D	-0.05%	-0.25%	-0.27%	100%	100%	0.04%	0.23%	-0.10%	101%	100%
Class F (optional)	-0.06%	-0.33%	0.10%	100%	100%	0.20%	0.52%	0.70%	101%	100%