



# CE13: Sample Adaptive Offset with LCU-Independent Decoding

Chih-Ming Fu, Ching-Yeh Chen, Chia-Yang Tsai, Yu-Wen Huang, and Shawmin Lei



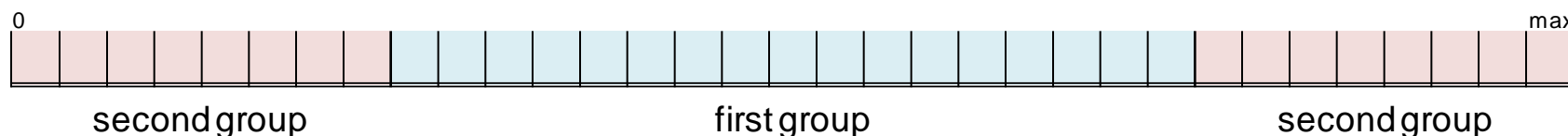
# Overall Summary

- Sample Adaptive Offset (**SAO**)
  - Located after Deblocking
  - Local adaptation by selecting Band Offset (BO) or Edge Offset (EO) for each region
  - Pixel classification and then derive one offset for each category
  - SAO decoding: LCU-independent
    - No line buffer is needed on SAD decoder
- Performance in comparison with JCTVC-D600

	HE-AI	HE-RA	HE-LD	LC-AI	LC-RA	LC-LD
<b>BD-Rate</b>	-0.5%	-1.3%	-2.2%	-0.7%	-1.8%	-3.0%
<b>Encoding Time</b>	100%	100%	100%	99%	100%	99%
<b>Decoding Time</b>	101%	103%	103%	102%	101%	101%

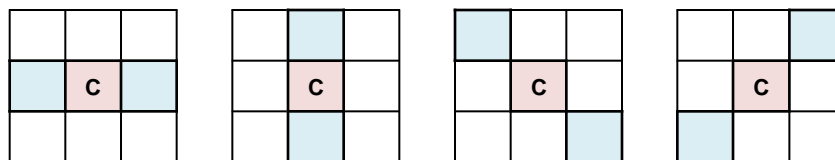
# Band Offset (BO)

- Classify each pixel according to its intensity
- Intensity is equally divided into 32 bands
  - To increase the possibility of nonzero offsets in comparison with the 16-band prior art
- To reduce side information (from 32 offsets to 16)
  - Send offsets of center 16 bands (group 1)
  - Send offsets of outer 16 bands (group 2)



# Edge Offset (EO)

- Classify each pixel by comparing with its neighboring pixels
- Send one offset for each category
- Four 1-D patterns



Category	Condition
1	$c < 2$ neighboring pixels
2	$c < 1$ neighbor && $c == 1$ neighbor
3	$c > 1$ neighbor && $c == 1$ neighbor
4	$c > 2$ neighbors
0	None of the above

# LCU-independent Decoding

- The edge-offset for LCU boundary pixels is skipped if its classification pattern is across the boundary, i.e.,
  - Pixels of the top and bottom rows in each LCU are not processed when the 90-degree, 135-degree, and 45-degree patterns are selected;
  - Pixels of the leftmost and rightmost columns in each LCU are not processed when the 0-degree, 135-degree, and 45-degree patterns are selected.

# Simulation Results

JCTVC-E049

Anchor JCTVC-D600, ALF-on		HE-AI	HE-RA	HE-LD	LC-AI	LC-RA	LC-LD
		Y BD-rate	Y BD-rate	Y BD-rate	Y BD-rate	Y BD-rate	Y BD-rate
Class A 2560x1600	Traffic	-0.6	-1.4		-0.9	-1.5	
	PeopleOnStreet	-1.0	-1.5		-1.4	-2.3	
	Nebuta	-0.2	-0.8		-0.2	-2.8	
	SteamLocomotive	-0.2	-0.9		-0.4	-3.2	
Class B 1080p	Kimono	-0.3	-0.5	-0.9	-0.5	-0.9	-3.2
	ParkScene	-0.5	-0.7	-1.6	-0.5	-1.0	-2.8
	Cactus	-0.4	-1.6	-2.1	-0.6	-2.3	-3.4
	BasketballDrive	-0.4	-1.1	-1.8	-0.6	-2.1	-3.4
	BQTerrace	-0.4	-3.7	-4.0	-0.6	-5.5	-5.4
Class C WVGA	BasketballDrill	-1.4	-2.4	-3.9	-1.7	-2.3	-4.1
	BQMall	-0.4	-1.4	-2.7	-0.6	-1.4	-3.2
	PartyScene	-0.2	-0.9	-2.0	-0.3	-0.3	-2.1
	RaceHorses	-0.4	-0.8	-1.0	-0.5	-2.2	-2.7
Class D WQVGA	BasketballPass	-0.4	-0.5	-1.0	-0.6	-0.8	-1.9
	BQSquare	-1.0	-2.7	-3.4	-0.9	-1.2	-2.2
	BlowingBubbles	-0.2	-0.6	-1.3	-0.3	0.1	-0.7
	RaceHorses	-0.4	-0.6	-1.3	-0.5	-1.3	-2.1
Class E 720p	Vidyo1	-0.7		-2.7	-1.0		-2.7
	Vidyo3	-0.9		-4.5	-1.0		-6.2
	Vidyo4	-0.5		-1.1	-0.8		-2.6
Summary	Class A	-0.5	-1.3		-0.7	-2.5	
	Class B	-0.4	-1.5	-2.1	-0.6	-2.4	-3.6
	Class C	-0.6	-1.3	-2.4	-0.8	-1.5	-3.0
	Class D	-0.5	-1.1	-1.8	-0.6	-0.8	-1.7
	Class E	-0.7		-2.8	-0.9		-3.8
	All	-0.5	-1.3	-2.2	-0.7	-1.8	-3.0
	Enc Time %	100%	100%	100%	99%	100%	99%
	Dec Time %	101%	103%	103%	102%	101%	101%

Anchor JCTVC-D600, ALF-off		HE-AI	HE-RA	HE-LD
		Y BD-rate	Y BD-rate	Y BD-rate
Class A 2560x1600	Traffic	-1.1	-1.8	
	PeopleOnStreet	-1.5	-2.3	
	Nebuta	-0.3	-2.6	
	SteamLocomotive	-0.4	-3.0	
Class B 1080p	Kimono	-0.6	-0.9	-2.3
	ParkScene	-0.8	-1.4	-2.7
	Cactus	-0.7	-2.6	-2.7
	BasketballDrive	-0.7	-2.0	-2.5
	BQTerrace	-0.7	-5.6	-4.1
Class C WVGA	BasketballDrill	-1.9	-2.1	-2.8
	BQMall	-0.7	-1.3	-2.5
	PartyScene	-0.5	-0.3	-1.7
	RaceHorses	-0.7	-2.4	-2.5
Class D WQVGA	BasketballPass	-0.7	-0.7	-1.7
	BQSquare	-1.0	-0.9	-1.8
	BlowingBubbles	-0.5	0.1	-0.5
	RaceHorses	-0.8	-1.4	-2.3
Class E 720p	Vidyo1	-1.0		-2.6
	Vidyo3	-1.0		-5.3
	Vidyo4	-0.8		-1.9
Summary	Class A	-0.8	-1.8	
	Class B	-0.7	-2.5	-2.9
	Class C	-1.0	-1.5	-2.4
	Class D	-0.7	-0.7	-1.6
	Class E	-1.0		-3.2
	All	-0.8	-1.8	-2.5
	Enc Time %	100%	100%	100%
	Dec Time %	103%	102%	102%

# Conclusions

- Sample adaptive offset (SAO)
- Performance compared with JCTVC-D600
- Propose to adopt SAO into HM, especially for Low-Complexity configurations

	HE-AI	HE-RA	HE-LD	LC-AI	LC-RA	LC-LD
<b>BD-Rate</b>	-0.5%	-1.3%	-2.2%	-0.7%	-1.8%	-3.0%
<b>Encoding Time</b>	100%	100%	100%	99%	100%	99%
<b>Decoding Time</b>	101%	103%	103%	102%	101%	101%

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