

JCTVC-U0101

CE1 Test C.1: Improved palette run-length coding with palette reverse scan order

Xiaoyu Xiu, Yan Ye, Yuwen He (InterDigital)

Wei Pu, Rajan Joshi, Marta Karczewicz, Feng Zou, Vadim Seregin (Qualcomm)

Proposal

- Run-length coding method in HEVC SCC draft 3
 - The flag *last_palette_run_type_flag* is signaled to indicate the last run of one palette CU.
 - It can only be applied to code the last run.
- The proposed palette reverse scan
 - CU level *palette_reverse_scan_flag* to indicate whether to scan palette indices reversely.
 - This allows *last_palette_run_type_flag* to also be applied the first run.

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1
1	1	0	0	0	0	0	2
2	2	0	0	0	0	0	0
1	1	1	1	0	0	0	0

(a) Original scan order

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	1
0	0	0	0	0	0	0	1
1	1	0	0	0	0	0	2
2	2	0	0	0	0	0	0
1	1	1	1	0	0	0	0

(b) Reverse scan order

Proposal

- The proposed encoder improvements
 - When index mode is followed by copy-above mode, determine the optimal combination of index run and copy-above run
 - Optimally determine the length of last run based on RD cost

Simulation performance

- Lossy 444 using full frame IBC search
- Gain for *text & graphics with motion*
 - AI: {0.7%, 0.9%, 1.0%}
 - RA: {0.4%, 0.6%, 0.7%}
 - LD: {0.5%, 0.6%, 0.6%}

	All Intra			Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-0.6%	-0.7%	-0.7%	-0.4%	-0.5%	-0.5%	-0.4%	-0.5%	-0.5%
RGB, mixed content, 1440p & 1080p	-0.2%	-0.4%	-0.4%	0.0%	-0.2%	-0.2%	0.1%	-0.2%	-0.1%
RGB, Animation, 720p	0.0%	-0.1%	-0.1%	0.0%	-0.1%	0.0%	-0.1%	0.1%	0.0%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	-0.9%	-1.1%	-1.2%	-0.5%	-0.7%	-0.9%	-0.5%	-0.7%	-0.7%
YUV, mixed content, 1440p & 1080p	-0.4%	-0.9%	-1.1%	-0.2%	-0.6%	-1.0%	0.1%	-0.4%	-0.6%
YUV, Animation, 720p	0.0%	-0.4%	-0.4%	-0.1%	-0.6%	-0.4%	-0.1%	-0.1%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%	0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.2%
Enc Time[%]	103%			98%			100%		
Dec Time[%]	101%			100%			102%		

Simulation performance

- Lossy 444 using local IBC search
- Gain for *text & graphics with motion*
 - AI: {0.9%, 1.1%, 1.2%}
 - RA: {0.5%, 0.7%, 0.7%}
 - LD: {0.4%, 0.5%, 0.6%}

	All Intra			Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics with motion, 1080p & 720p	-0.8%	-0.9%	-0.9%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.4%
RGB, mixed content, 1440p & 1080p	-0.3%	-0.5%	-0.5%	-0.1%	-0.2%	-0.2%	0.0%	-0.2%	-0.1%
RGB, Animation, 720p	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.1%	-0.1%	-0.1%
RGB, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics with motion, 1080p & 720p	-1.1%	-1.3%	-1.4%	-0.6%	-0.9%	-0.9%	-0.4%	-0.5%	-0.8%
YUV, mixed content, 1440p & 1080p	-0.5%	-1.1%	-1.2%	-0.2%	-0.7%	-0.9%	-0.1%	-0.7%	-0.9%
YUV, Animation, 720p	0.0%	-0.4%	-0.4%	0.0%	-0.2%	-0.4%	0.1%	-0.1%	0.0%
YUV, camera captured, 1080p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Enc Time[%]	104%			103%			103%		
Dec Time[%]	104%			101%			103%		

Simulation performance

- Lossless 444 coding
- *text & graphics with motion*
 - 0.2%, 0.1%, 0.1% for AI, RA and LB, respectively

All Intra				Random Access				Low Delay B			
Bit-rate change (Total)	Bit-rate change (Average)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Average)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Average)	Bit-rate change (Min)	Bit-rate change (Max)
-0.2%	-0.3%	-0.6%	-0.1%	-0.1%	-0.2%	-0.4%	0.0%	-0.1%	-0.1%	-0.3%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
-0.3%	-0.3%	-0.8%	-0.1%	-0.1%	-0.2%	-0.5%	0.1%	-0.1%	-0.2%	-0.5%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
103%				93%				92%			
90%				91%				92%			

Simulation performance

- Lossy 420 coding
- Gain for *text & graphics with motion*
 - AI: {0.7%, 0.7%, 0.9%}
 - RA: {0.5%, 0.5%, 0.7%}
 - LD: {0.3%, 0.6%, 0.5%}

	All Intra			Random Access			Low delay B		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
YUV, text & graphics with motion, 1080p & 720p	-0.7%	-0.7%	-0.9%	-0.5%	-0.5%	-0.7%	-0.3%	-0.6%	-0.5%
YUV, mixed content, 1440p & 1080p	-0.3%	-0.5%	-0.6%	-0.1%	-0.4%	-0.7%	-0.2%	-0.6%	-0.6%
YUV, Animation, 720p & 768p	-0.3%	-0.5%	-0.6%	-0.1%	-0.4%	-0.6%	-0.1%	-0.3%	-0.2%
Enc Time[%]	106%			95%			93%		
Dec Time[%]	91%			91%			94%		

Simulation performance

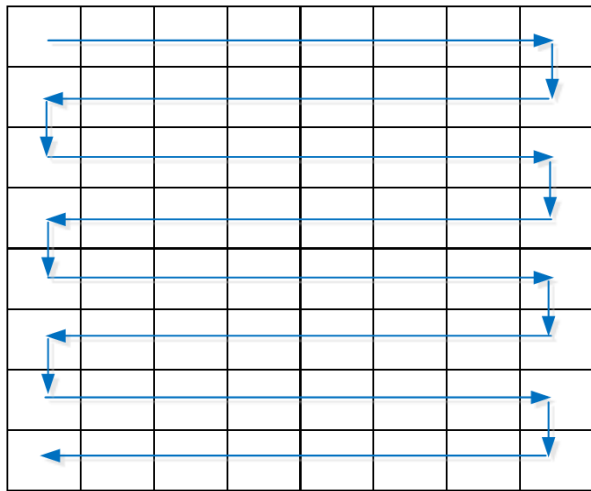
- Lossless 420 coding
- *text & graphics with motion*
 - 0.1%, 0.0% and 0.0% for AI, RA and LB, respectively

All Intra				Random Access				Low Delay B			
Bit-rate change (Total)	Bit-rate change (Average)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Average)	Bit-rate change (Min)	Bit-rate change (Max)	Bit-rate change (Total)	Bit-rate change (Average)	Bit-rate change (Min)	Bit-rate change (Max)
-0.1%	-0.1%	-0.2%	0.0%	0.0%	0.0%	-0.1%	0.1%	0.0%	0.1%	-0.1%	0.6%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
102%				97%				96%			
90%				97%				95%			

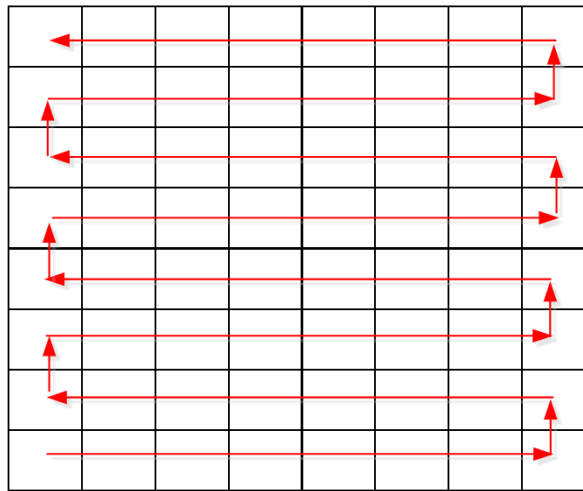
Thanks to Canon for the cross-check!

Comparison of Test C.1 and Test C.2

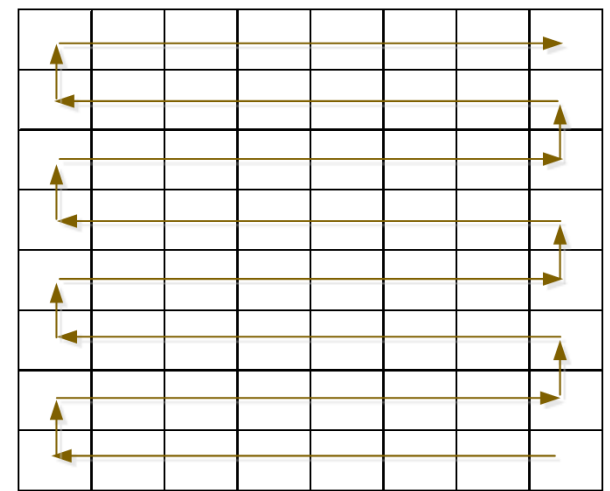
- Illustrations of different scans
 - Palette reverse scan: use the same scan pattern as horizontal/vertical scan, but scan order is reversed
 - Palette rotation scan: use a different scan pattern as horizontal/vertical scan



(a) Original horizontal scan



(b) Reverse horizontal scan (Test C.1)



(c) Rotated horizontal scan (Test C.2)

Comparison of Test C.1 and Test C.2

- Comparison of spec changes
 - Palette reverse scan: only needs to update vertical coordinate for palette CU reconstruction

$$S_L[xCb + x][yCb + y] = \text{palette_reverse_scan_flag? } \text{recSamples}[x][nCbS - y]: \text{recSamples}[x][y] \quad (8-14)$$

- Palette rotation scan: needs to update both horizontal and vertical coordinates for palette CU reconstruction

$$S_L[xCb + x][yCb + y] = \text{palette_rotated_scan_flag? } \text{recSamples}[nCbS - x][nCbS - y]: \text{recSamples}[x][y] \quad (8-14)$$

Comparison of Test C.1 and Test C.2

- Using the same RDO method of CE.1 Test C.1 (released on May 30, 2015)
- Similar BD-rate performance

All Intra (C.1)			All Intra (C.2)		
G/Y	B/U	R/V	G/Y	B/U	R/V
-0.6%	-0.7%	-0.7%	-0.7%	-0.7%	-0.8%
-0.2%	-0.4%	-0.4%	-0.2%	-0.4%	-0.4%
0.0%	-0.1%	-0.1%	0.0%	-0.1%	-0.1%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
-0.9%	-1.1%	-1.2%	-1.0%	-1.2%	-1.2%
-0.4%	-0.9%	-1.1%	-0.4%	-0.9%	-1.0%
0.0%	-0.4%	-0.4%	0.0%	-0.5%	-0.5%
0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
103%			107%		
101%			100%		

Random Access (C.1)			Random Access (C.2)		
G/Y	B/U	R/V	G/Y	B/U	R/V
-0.4%	-0.5%	-0.5%	-0.4%	-0.6%	-0.5%
0.0%	-0.2%	-0.2%	0.0%	-0.3%	-0.2%
0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%
0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
-0.5%	-0.7%	-0.9%	-0.6%	-0.9%	-1.1%
-0.2%	-0.6%	-1.0%	-0.2%	-0.7%	-1.1%
-0.1%	-0.6%	-0.4%	-0.1%	-0.6%	-0.4%
0.1%	-0.1%	-0.1%	0.0%	0.0%	-0.1%
98%			101%		
100%			99%		

Low delay B (C.1)			Low delay B (C.2)		
G/Y	B/U	R/V	G/Y	B/U	R/V
-0.4%	-0.5%	-0.5%	-0.5%	-0.5%	-0.4%
0.1%	-0.2%	-0.1%	0.2%	0.0%	0.0%
-0.1%	0.1%	0.0%	-0.1%	0.1%	0.1%
0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
-0.5%	-0.7%	-0.7%	-0.5%	-0.8%	-0.9%
0.1%	-0.4%	-0.6%	0.2%	-0.5%	-0.8%
-0.1%	-0.1%	0.0%	0.1%	-0.1%	-0.3%
-0.1%	0.0%	0.2%	-0.1%	0.0%	0.0%
100%			100%		
102%			101%		

Closing remarks

- The proposed methods
 - One CU-level flag is proposed to indicate whether or not to scan palette indices reversely
 - Encoder improvements for run-length coding
- Coding performance
 - Average BD-rate savings for AI, RA and LB are 0.7%, -0.4% and 0.5%, respectively, for lossy 444 coding
 - Average BD-rate savings for AI, RA and LB are 0.7%, -0.5 and 0.3%, respectively, for lossy 420 coding
- Suggest to adopt to SCC