

JCTVC-R0132

Non-SCCE2: Line-based Intra Copy with Unconstrained 2-D BV Coding for Test C

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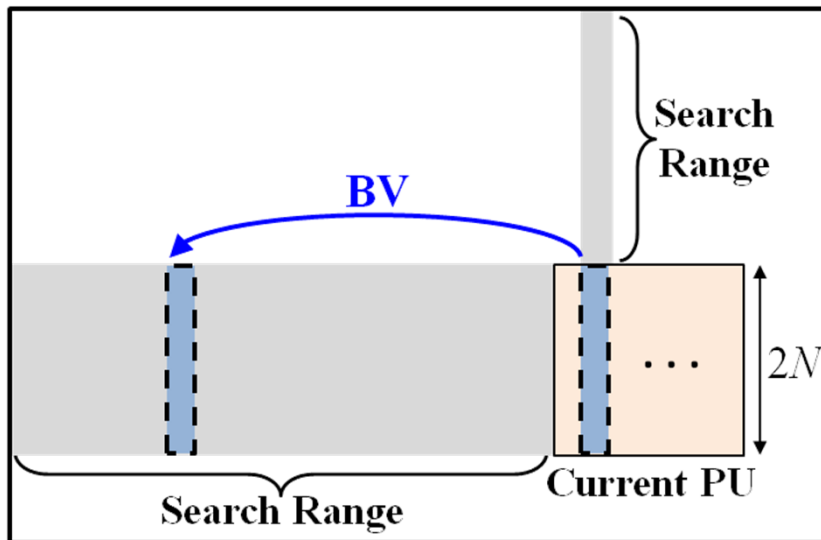
C.-L. Lin (ITRI), et. al.

Sapporo, Japan, 2014

- * Extend horizontal and vertical BVs to 2-D
- * Align the BV decoding process with that of IntraBC
- * Introduce hash-based line search (JCTVC-R0098)

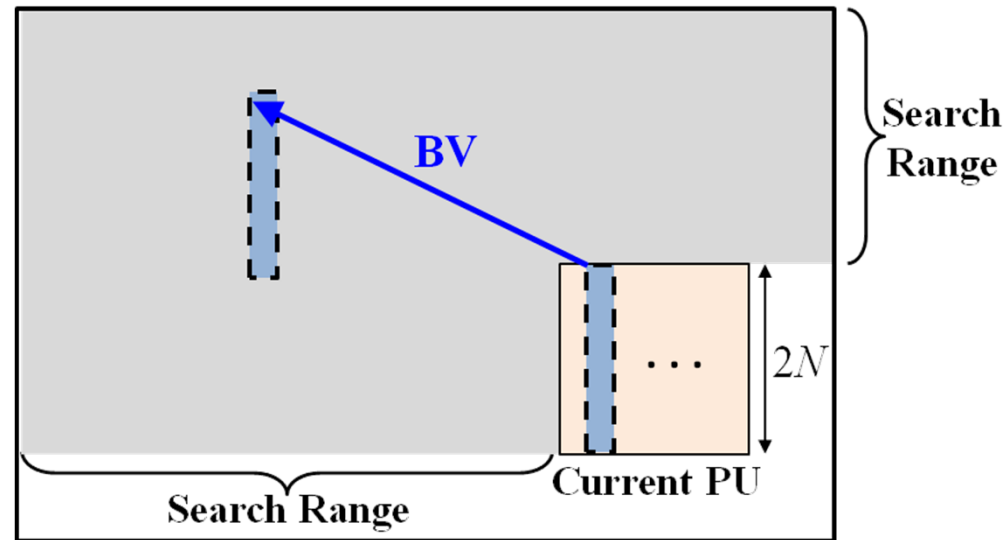
Ver./Hor. BV (Test C)

Current Frame



2-D BV (Aligned with IntraBC)

Current Frame



* Encoder-only options: 2 CTUs or Full Frame

Lossy (G/Y BD-rate)	All Intra			Random Access			Low Delay B		
	Test C	2-CTU	Frame	Test C	2-CTU	Frame	Test C	2-CTU	Frame
RGB, text & graphics w/ motion, 1080p	-7.0%	-9.4%	-12.9%	-4.1%	-5.2%	-7.0%	-2.5%	-2.8%	-3.8%
RGB, text & graphics w/ motion, 720p	-3.2%	-4.4%	-6.0%	-2.3%	-3.5%	-4.6%	-1.5%	-2.1%	-2.5%
RGB, mixed content, 1440p	-2.8%	-2.7%	-3.3%	-2.1%	-2.1%	-2.3%	-1.1%	-1.2%	-1.5%
RGB, mixed content, 1080p	-3.7%	-3.6%	-6.0%	-2.6%	-2.7%	-4.2%	-1.3%	-1.2%	-2.0%
YUV, text & graphics w/ motion, 1080p	-6.6%	-8.8%	-12.0%	-3.6%	-4.9%	-6.3%	-2.2%	-2.5%	-3.2%
YUV, text & graphics w/ motion, 720p	-2.5%	-3.3%	-4.7%	-2.1%	-2.7%	-3.8%	-0.9%	-1.1%	-1.6%
YUV, mixed content, 1440p	-2.2%	-2.1%	-2.7%	-1.3%	-1.3%	-1.7%	-0.7%	-0.7%	-0.6%
YUV, mixed content, 1080p	-3.2%	-3.0%	-5.2%	-2.4%	-2.2%	-4.0%	-0.5%	-0.4%	-1.4%
Enc Time[%]	113%	127%	126%	103%	103%	104%	103%	102%	103%
Dec Time[%]	101%	99%	99%	104%	101%	102%	102%	102%	102%

Lossless (Average Bit-rate Saving)	All Intra			Random Access			Low Delay B		
	Test C	2-CTU	Frame	Test C	2-CTU	Frame	Test C	2-CTU	Frame
RGB, text & graphics w/ motion, 1080p	6.5%	10.9%	15.5%	4.0%	7.0%	10.4%	3.0%	5.6%	8.2%
RGB, text & graphics w/ motion, 720p	1.7%	4.8%	5.8%	1.0%	2.5%	3.1%	0.7%	1.8%	2.1%
RGB, mixed content, 1440p	1.0%	1.2%	2.2%	0.2%	0.2%	0.4%	0.2%	0.1%	0.3%
RGB, mixed content, 1080p	1.3%	1.6%	3.4%	0.2%	0.3%	0.5%	0.1%	0.1%	0.2%
YUV, text & graphics w/ motion, 1080p	6.5%	13.2%	17.8%	4.1%	8.6%	12.0%	3.1%	6.9%	9.5%
YUV, text & graphics w/ motion, 720p	2.1%	5.6%	7.1%	1.3%	3.3%	4.3%	0.9%	2.3%	2.8%
YUV, mixed content, 1440p	1.0%	1.3%	2.5%	0.2%	0.2%	0.4%	0.2%	0.1%	0.2%
YUV, mixed content, 1080p	1.3%	1.7%	3.6%	0.2%	0.3%	0.6%	0.1%	0.1%	0.2%
Enc Time[%]	121%	129%	126%	104%	101%	101%	102%	105%	105%
Dec Time[%]	99%	101%	102%	104%	102%	102%	102%	103%	103%

Comparison with String Matching (R0098)

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Lossy (G/Y BD-rate)	All Intra		Random Access		Low Delay B	
	Frame	R0098	Frame	R0098	Frame	R0098
RGB, text & graphics w/ motion, 1080p	-12.9%	-13.3%	-7.0%	-8.3%	-3.8%	-5.9%
RGB, text & graphics w/ motion, 720p	-6.0%	-6.7%	-4.6%	-5.2%	-2.5%	-3.1%
RGB, mixed content, 1440p	-3.3%	-1.7%	-2.3%	-1.1%	-1.5%	-0.6%
RGB, mixed content, 1080p	-6.0%	-4.6%	-4.2%	-3.1%	-2.0%	-1.7%
YUV, text & graphics w/ motion, 1080p	-12.0%	-11.4%	-6.3%	-6.9%	-3.2%	-4.5%
YUV, text & graphics w/ motion, 720p	-4.7%	-5.4%	-3.8%	-4.4%	-1.6%	-2.1%
YUV, mixed content, 1440p	-2.7%	-1.5%	-1.7%	-0.9%	-0.6%	-0.4%
YUV, mixed content, 1080p	-5.2%	-4.0%	-4.0%	-2.7%	-1.4%	-1.1%
Enc Time[%]	126%	132%	104%	103%	103%	102%
Dec Time[%]	99%	96%	102%	99%	102%	99%

Lossless (Average Bit-rate Saving)	All Intra		Random Access		Low Delay B	
	Frame	R0098	Frame	R0098	Frame	R0098
RGB, text & graphics w/ motion, 1080p	15.5%	20.0%	10.4%	14.1%	8.2%	11.4%
RGB, text & graphics w/ motion, 720p	5.8%	8.3%	3.1%	4.4%	2.1%	2.8%
RGB, mixed content, 1440p	2.2%	2.0%	0.4%	0.4%	0.3%	0.2%
RGB, mixed content, 1080p	3.4%	3.2%	0.5%	0.5%	0.2%	0.2%
YUV, text & graphics w/ motion, 1080p	17.8%	22.3%	12.0%	15.8%	9.5%	12.8%
YUV, text & graphics w/ motion, 720p	7.1%	9.2%	4.3%	5.5%	2.8%	3.5%
YUV, mixed content, 1440p	2.5%	2.3%	0.4%	0.3%	0.2%	0.2%
YUV, mixed content, 1080p	3.6%	3.3%	0.6%	0.5%	0.2%	0.2%
Enc Time[%]	126%	156%	101%	107%	105%	105%
Dec Time[%]	102%	94%	102%	99%	103%	99%

- * This contribution reports improvements on Test C by removing the horizontal/vertical search constraint and introducing hash-based line search
- * Results provided for 2-CTU and full-frame search areas

	Test C	2-CTU	Full Frame	Recon. 1-D Dict.
All Intra	2.2-7.0%	2.1-9.4%	2.7-12.9%	1.5-13.3%
Random Access	1.3-4.1%	1.3-5.2%	1.7-7.0%	0.9-8.3%
Low Delay B	0.5-2.5%	0.4-2.8%	0.6-3.8%	0.4-5.9%

- * Recommend to further study in a CE

Appendix: Full Results

Lossy	Test C			2-CTU			Full-Frame		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics w/ motion, 1080p	-7.0%	-7.0%	-6.9%	-9.4%	-9.3%	-9.2%	-12.9%	-12.8%	-12.8%
RGB, text & graphics w/ motion,720p	-3.2%	-3.2%	-3.2%	-4.4%	-4.2%	-4.2%	-6.0%	-6.0%	-6.0%
RGB, mixed content, 1440p	-2.8%	-2.7%	-2.8%	-2.7%	-2.6%	-2.6%	-3.3%	-3.3%	-3.4%
RGB, mixed content, 1080p	-3.7%	-3.8%	-3.8%	-3.6%	-3.6%	-3.7%	-6.0%	-6.1%	-6.2%
RGB, Animation, 720p	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%
YUV, text & graphics w/ motion, 1080p	-6.6%	-6.5%	-6.5%	-8.8%	-8.7%	-8.6%	-12.0%	-11.8%	-11.7%
YUV, text & graphics w/ motion,720p	-2.5%	-3.0%	-3.3%	-3.3%	-3.8%	-4.3%	-4.7%	-5.0%	-5.5%
YUV, mixed content, 1440p	-2.2%	-2.7%	-2.9%	-2.1%	-2.8%	-3.0%	-2.7%	-3.1%	-3.3%
YUV, mixed content, 1080p	-3.2%	-3.9%	-3.7%	-3.0%	-3.8%	-3.7%	-5.2%	-5.8%	-5.5%
YUV, Animation, 720p	0.0%	-0.1%	-0.1%	0.0%	-0.2%	-0.2%	0.0%	0.0%	-0.1%
Enc Time[%]	113%			127%			126%		
Dec Time[%]	101%			99%			99%		
Lossless	Test C			2-CTU			Full-Frame		
	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max
RGB, text & graphics w/ motion, 1080p	6.5%	4.3%	10.2%	10.9%	7.8%	16.1%	15.5%	9.6%	24.7%
RGB, text & graphics w/ motion,720p	1.7%	0.5%	3.2%	4.8%	0.9%	8.1%	5.8%	0.7%	10.2%
RGB, mixed content, 1440p	1.0%	0.6%	1.4%	1.2%	0.5%	1.8%	2.2%	1.9%	2.6%
RGB, mixed content, 1080p	1.3%	1.3%	1.3%	1.6%	1.6%	1.6%	3.4%	3.4%	3.4%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%
YUV, text & graphics w/ motion, 1080p	6.5%	4.3%	9.9%	13.2%	8.2%	19.0%	17.8%	12.0%	28.8%
YUV, text & graphics w/ motion,720p	2.1%	0.4%	4.6%	5.6%	0.8%	10.1%	7.1%	0.7%	15.7%
YUV, mixed content, 1440p	1.0%	0.5%	1.4%	1.3%	0.5%	2.1%	2.5%	1.8%	3.1%
YUV, mixed content, 1080p	1.3%	1.3%	1.3%	1.7%	1.7%	1.7%	3.6%	3.6%	3.6%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%
Enc Time[%]	121%			129%			126%		
Dec Time[%]	99%			101%			102%		

Random Access

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Lossy	Test C			2-CTU			Full-Frame		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics w/ motion, 1080p	-4.1%	-4.0%	-4.0%	-5.2%	-5.2%	-5.0%	-7.0%	-6.9%	-6.9%
RGB, text & graphics w/ motion,720p	-2.3%	-2.2%	-2.4%	-3.5%	-3.0%	-3.2%	-4.6%	-4.4%	-4.6%
RGB, mixed content, 1440p	-2.1%	-1.9%	-1.9%	-2.1%	-1.9%	-2.0%	-2.3%	-2.1%	-2.2%
RGB, mixed content, 1080p	-2.6%	-2.7%	-2.7%	-2.7%	-2.7%	-2.9%	-4.2%	-4.2%	-4.2%
RGB, Animation, 720p	-0.1%	-0.1%	-0.1%	-0.2%	-0.2%	-0.1%	-0.1%	-0.1%	0.0%
YUV, text & graphics w/ motion, 1080p	-3.6%	-3.9%	-3.9%	-4.9%	-5.2%	-5.1%	-6.3%	-6.4%	-6.4%
YUV, text & graphics w/ motion,720p	-2.1%	-2.6%	-2.6%	-2.7%	-3.3%	-3.6%	-3.8%	-4.1%	-4.4%
YUV, mixed content, 1440p	-1.3%	-2.4%	-2.1%	-1.3%	-2.7%	-2.5%	-1.7%	-2.4%	-2.6%
YUV, mixed content, 1080p	-2.4%	-3.1%	-3.0%	-2.2%	-3.6%	-3.2%	-4.0%	-4.5%	-4.5%
YUV, Animation, 720p	-0.1%	-0.2%	0.0%	0.0%	-0.3%	0.0%	0.0%	-0.2%	0.1%
Enc Time[%]	103%			103%			104%		
Dec Time[%]	104%			101%			102%		
Lossless	Test C			2-CTU			Full-Frame		
	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max
RGB, text & graphics w/ motion, 1080p	4.0%	1.7%	7.4%	7.0%	3.6%	11.6%	10.4%	3.7%	17.4%
RGB, text & graphics w/ motion,720p	1.0%	0.3%	2.7%	2.5%	0.5%	5.4%	3.1%	0.4%	8.5%
RGB, mixed content, 1440p	0.2%	0.1%	0.4%	0.2%	0.2%	0.3%	0.4%	0.2%	0.6%
RGB, mixed content, 1080p	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.5%	0.5%	0.5%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics w/ motion, 1080p	4.1%	2.0%	7.5%	8.6%	5.8%	14.1%	12.0%	5.3%	20.7%
YUV, text & graphics w/ motion,720p	1.3%	0.3%	3.9%	3.3%	0.5%	8.7%	4.3%	0.4%	13.3%
YUV, mixed content, 1440p	0.2%	0.1%	0.3%	0.2%	0.2%	0.2%	0.4%	0.3%	0.6%
YUV, mixed content, 1080p	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.6%	0.6%	0.6%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	104%			101%			101%		
Dec Time[%]	104%			102%			102%		

Low Delay B

Lossy	Test C			2-CTU			Full-Frame		
	G/Y	B/U	R/V	G/Y	B/U	R/V	G/Y	B/U	R/V
RGB, text & graphics w/ motion, 1080p	-2.5%	-2.4%	-2.3%	-2.8%	-2.8%	-2.6%	-3.8%	-3.7%	-3.6%
RGB, text & graphics w/ motion,720p	-1.5%	-1.4%	-1.5%	-2.1%	-1.6%	-1.9%	-2.5%	-2.1%	-2.3%
RGB, mixed content, 1440p	-1.1%	-1.3%	-1.1%	-1.2%	-1.2%	-1.1%	-1.5%	-1.5%	-1.3%
RGB, mixed content, 1080p	-1.3%	-1.3%	-1.3%	-1.2%	-0.8%	-1.3%	-2.0%	-1.7%	-1.9%
RGB, Animation, 720p	0.0%	0.0%	0.0%	-0.1%	0.0%	0.1%	0.0%	0.0%	0.0%
YUV, text & graphics w/ motion, 1080p	-2.2%	-2.4%	-2.5%	-2.5%	-2.7%	-2.8%	-3.2%	-3.5%	-3.3%
YUV, text & graphics w/ motion,720p	-0.9%	-1.1%	-1.8%	-1.1%	-1.5%	-1.8%	-1.6%	-1.7%	-2.1%
YUV, mixed content, 1440p	-0.7%	-1.7%	-1.8%	-0.7%	-1.5%	-1.5%	-0.6%	-1.4%	-1.4%
YUV, mixed content, 1080p	-0.5%	-2.0%	-0.4%	-0.4%	-1.2%	-1.2%	-1.4%	-2.0%	-1.4%
YUV, Animation, 720p	-0.1%	-0.5%	-0.2%	0.0%	-0.3%	-0.3%	-0.1%	-0.4%	-0.2%
Enc Time[%]	103%			102%			103%		
Dec Time[%]	103%			102%			102%		
Lossless	Test C			2-CTU			Full-Frame		
	Avg.	Min	Max	Avg.	Min	Max	Avg.	Min	Max
RGB, text & graphics w/ motion, 1080p	3.0%	1.3%	4.9%	5.6%	3.0%	8.2%	8.2%	3.0%	11.7%
RGB, text & graphics w/ motion,720p	0.7%	0.2%	1.8%	1.8%	0.4%	4.0%	2.1%	0.3%	5.8%
RGB, mixed content, 1440p	0.2%	0.0%	0.3%	0.1%	0.1%	0.2%	0.3%	0.1%	0.4%
RGB, mixed content, 1080p	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%
RGB, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
YUV, text & graphics w/ motion, 1080p	3.1%	1.6%	5.1%	6.9%	5.3%	9.9%	9.5%	4.5%	14.2%
YUV, text & graphics w/ motion,720p	0.9%	0.2%	2.6%	2.3%	0.4%	6.0%	2.8%	0.3%	8.8%
YUV, mixed content, 1440p	0.2%	0.0%	0.3%	0.1%	0.1%	0.2%	0.2%	0.1%	0.4%
YUV, mixed content, 1080p	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%	0.2%
YUV, Animation, 720p	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	102%			105%			105%		
Dec Time[%]	102%			103%			103%		