

**Yu-Ling Hsiao, Tzu-Der Chuang, Ching-Yeh Chen,
Chih-Wei Hsu, Yu-Wen Huang, Shaw-Min Lei**

Presenter: Tzu-Der Chuang

Overall Summary

- Pairwise average candidates are generated by averaging predefined pairs of candidates in the current merge candidate list

VTM-2.0.1 (%), RA and LB		VTM			Run Time	
		Y	U	V	Enc	Dec
1	Pairwise average candidates with merge list size equals to 6, coexist with HEVC combined candidates	-0.40	-0.23	-0.34	100%	101%
		0.05	0.21	0.29	101%	102%
2	Pairwise average candidates with merge list size equals to 8, coexist with HEVC combined candidates	-0.61	-0.43	-0.56	101%	101%
		-0.11	0.11	0.01	102%	102%
3	Pairwise average candidates with merge list size equals to 10, coexist with HEVC combined candidates	-0.69	-0.50	-0.64	101%	102%
		-0.14	0.04	-0.10	102%	101%
4	Pairwise average candidates with merge list size equals to 6, replace HEVC combined candidates	-0.38	-0.21	-0.31	100%	101%
		0.01	0.14	0.13	101%	102%
5	Pairwise average candidates with merge list size equals to 8, replace HEVC combined candidates	-0.54	-0.37	-0.42	101%	100%
		-0.07	0.08	0.01	101%	102%
6	Pairwise average candidates with merge list size equals to 10, replace HEVC combined candidates	-0.61	-0.38	-0.54	101%	101%
		-0.16	-0.12	-0.15	102%	102%

Proposed Methods

- Average two different candidates in candidate list
 - Average when both MVs are available, even when they point to different reference pictures
 - Use MV when only one MV is available
 - Keep invalid when no MV is available
 - Calculated separately for each reference picture list
- Up to 6 pairs
 - $\{(0, 1), (0, 2), (1, 2), (0, 3), (1, 3), (2, 3)\}$
 - Numbers denote the merge indices to the merge candidate list

Proposed Methods

- Worst case of additional calculations for averaging
 - 4 additions and 4 shifts are needed for each pair (MVx and MVy in L0 and L1)
 - 4 reference index comparisons are needed for each pair (refIdx0 is valid and refIdx1 is valid in L0 and L1)
 - There are 6 pairs, leading to 24 additions, 24 shifts, and 24 reference index comparisons in total

Merge list size	Max number of potential candidates	Max number of candidate comparisons	Max number of MV scaling	Max number of temporal candidates	Additional local buffer	Max number of memory access	Others
6, 8, 10	6	0	0	0	0	0	Additional calculations for averaging, (Replace HEVC combined candidates)

Table 1. Pairwise average candidates with merge list size equal to 6

Random Access Main 10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	-0.50%	-0.28%	-0.45%	100%	101%
Class A2	-0.42%	-0.34%	-0.48%	100%	101%
Class B	-0.42%	-0.19%	-0.32%	100%	100%
Class C	-0.31%	-0.17%	-0.18%	100%	102%
Class E					
Overall	-0.40%	-0.23%	-0.34%	100%	101%
Class D	-0.39%	-0.44%	-0.49%	100%	99%
Class F (optional)	-0.08%	0.00%	-0.03%	100%	100%

Low delay B Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.01%	0.21%	0.11%	101%	105%
Class C	0.10%	0.15%	0.44%	101%	101%
Class E	0.05%	0.28%	0.40%	100%	99%
Overall	0.05%	0.21%	0.29%	101%	102%
Class D	0.12%	0.98%	0.32%	101%	100%
Class F (optional)	-0.12%	0.10%	0.28%	101%	101%

Table 2. Pairwise average candidates with merge list size equal to 8

Random Access Main 10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	-0.70%	-0.45%	-0.60%	100%	101%
Class A2	-0.69%	-0.60%	-0.76%	101%	102%
Class B	-0.58%	-0.34%	-0.57%	100%	100%
Class C	-0.51%	-0.41%	-0.38%	101%	101%
Class E					
Overall	-0.61%	-0.43%	-0.56%	101%	101%
Class D	-0.60%	-0.60%	-0.75%	101%	100%
Class F (optional)	-0.17%	-0.14%	-0.16%	101%	100%

Low delay B Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-0.09%	0.14%	-0.20%	102%	105%
Class C	-0.07%	0.01%	0.07%	102%	101%
Class E	-0.20%	0.20%	0.26%	101%	99%
Overall	-0.11%	0.11%	0.01%	102%	102%
Class D	0.01%	0.35%	-0.41%	102%	101%
Class F (optional)	-0.03%	0.53%	0.18%	102%	101%

Table 3. Pairwise average candidates with merge list size equal to 10

Random Access Main 10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	-0.78%	-0.44%	-0.70%	101%	104%
Class A2	-0.77%	-0.68%	-0.87%	101%	102%
Class B	-0.67%	-0.50%	-0.63%	101%	100%
Class C	-0.58%	-0.39%	-0.42%	102%	102%
Class E					
Overall	-0.69%	-0.50%	-0.64%	101%	102%
Class D	-0.70%	-0.65%	-0.87%	102%	100%
Class F (optional)	-0.19%	-0.15%	-0.23%	101%	101%

Low delay B Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-0.11%	0.16%	-0.20%	103%	103%
Class C	-0.14%	-0.03%	0.12%	103%	101%
Class E	-0.18%	-0.07%	-0.22%	102%	98%
Overall	-0.14%	0.04%	-0.10%	102%	101%
Class D	-0.08%	0.74%	0.09%	103%	99%
Class F (optional)	-0.01%	0.74%	0.66%	103%	100%

Table 4. Replacing HEVC combined candidates with pairwise average candidates with merge list size equal to 6

Random Access Main 10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	-0.49%	-0.38%	-0.42%	100%	102%
Class A2	-0.39%	-0.24%	-0.44%	100%	102%
Class B	-0.38%	-0.16%	-0.34%	100%	100%
Class C	-0.28%	-0.12%	-0.08%	100%	101%
Class E					
Overall	-0.38%	-0.21%	-0.31%	100%	101%
Class D	-0.32%	-0.33%	-0.35%	100%	100%
Class F (optional)	-0.11%	-0.06%	-0.07%	100%	101%

Low delay B Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.06%	0.26%	0.20%	101%	104%
Class C	0.08%	0.17%	0.32%	100%	101%
Class E	-0.19%	-0.09%	-0.23%	100%	100%
Overall	0.01%	0.14%	0.13%	101%	102%
Class D	0.15%	0.49%	-0.31%	101%	100%
Class F (optional)	-0.07%	0.46%	0.22%	101%	101%

Table 5. Replacing HEVC combined candidates with pairwise average candidates with merge list size equal to 8

Random Access Main 10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	-0.64%	-0.36%	-0.51%	100%	101%
Class A2	-0.62%	-0.51%	-0.59%	101%	102%
Class B	-0.52%	-0.36%	-0.35%	100%	99%
Class C	-0.44%	-0.28%	-0.32%	101%	101%
Class E					
Overall	-0.54%	-0.37%	-0.42%	101%	100%
Class D	-0.50%	-0.45%	-0.54%	100%	100%
Class F (optional)	-0.17%	-0.16%	-0.19%	101%	102%

Low delay B Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.06%	0.22%	-0.02%	102%	105%
Class C	-0.03%	0.08%	0.23%	101%	101%
Class E	-0.33%	-0.15%	-0.24%	101%	99%
Overall	-0.07%	0.08%	0.01%	101%	102%
Class D	0.08%	0.10%	0.13%	102%	100%
Class F (optional)	-0.04%	0.54%	0.21%	102%	101%

Table 6. Replacing HEVC combined candidates with pairwise average candidates with merge list size equal to 10

Random Access Main 10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	-0.73%	-0.37%	-0.62%	101%	102%
Class A2	-0.69%	-0.55%	-0.65%	101%	101%
Class B	-0.58%	-0.33%	-0.49%	101%	100%
Class C	-0.49%	-0.32%	-0.44%	102%	101%
Class E					
Overall	-0.61%	-0.38%	-0.54%	101%	101%
Class D	-0.61%	-0.60%	-0.61%	101%	99%
Class F (optional)	-0.16%	-0.13%	-0.14%	101%	100%

Low delay B Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-0.02%	-0.05%	0.03%	102%	103%
Class C	-0.06%	0.01%	0.21%	102%	103%
Class E	-0.53%	-0.42%	-0.91%	101%	100%
Overall	-0.16%	-0.12%	-0.15%	102%	102%
Class D	0.01%	0.38%	0.02%	103%	100%
Class F (optional)	-0.22%	0.16%	0.79%	102%	101%

Conclusions

- Pairwise average candidates are generated by averaging predefined pairs of candidates in the current merge candidate list

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1	Pairwise average candidates with merge list size equals to 6, coexist with HEVC combined candidates	-0.40	-0.23	-0.34	100%	101%
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4	Pairwise average candidates with merge list size equals to 6, replace HEVC combined candidates	-0.38	-0.21	-0.31	100%	101%
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		-0.16	-0.12	-0.15	102%	102%