

CE2-RELATED: ON RESTRICTION OF MEMORY BANDWIDTH CONSUMPTION OF AFFINE MODE (2X2 VARIANT) (JVET-N0369)

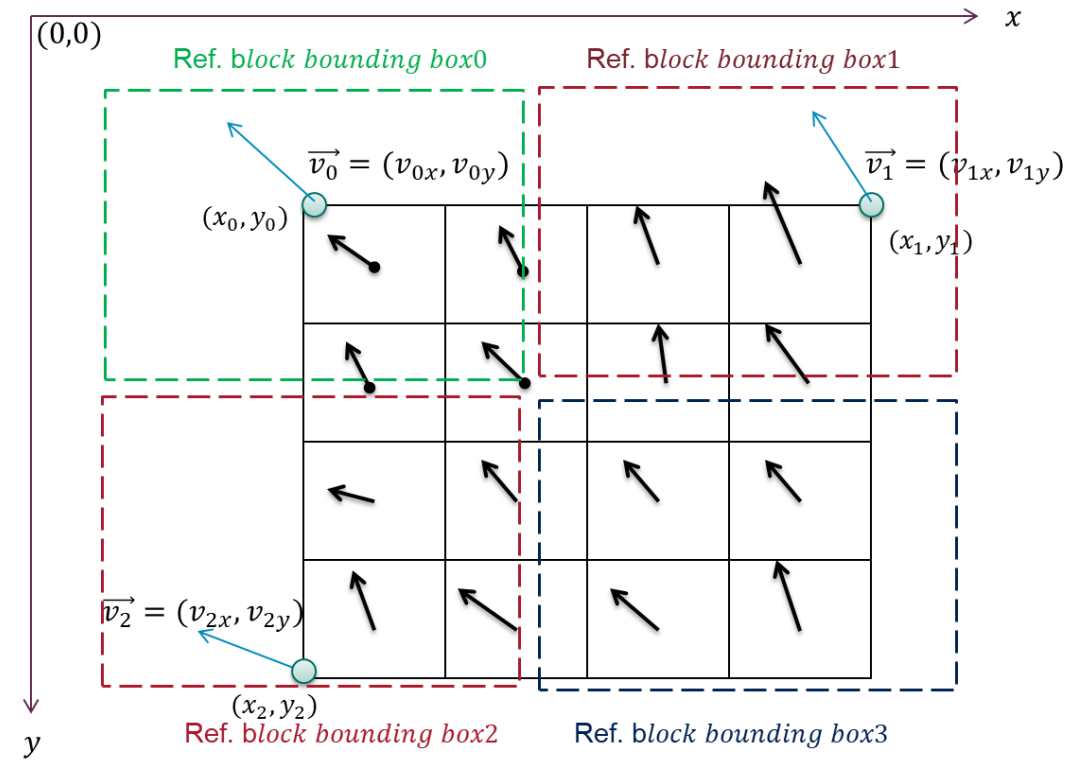


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Background

- In the current design, 4x4 sub-block size is used for the generation of sub-block vectors of affine mode
- The sub-block motion vector spread (i.e. how far the sub-block motion vectors can go apart from each other) needs to be constrained to avoid non-affordable peak memory bandwidth consumption of the affine mode.
- Most of methods being studied just constrain the sub-block motion vector spread for each 8x8 region of a PU
 - Within the PU the sub-block motion vectors can still go widely apart from one 8x8 region to the next 8x8 region
- Propose to impose the constraint at the PU level, not just at 8x8 level.



Proposed Method

- Directly constrain the affine motion model parameters
- For the model parameters (a,b,c,d) that lead to the reference block bounding box exceeding a pre-defined threshold, use a fallback mode for motion compensation. Otherwise, the regular affine MC applies.

- *Method*

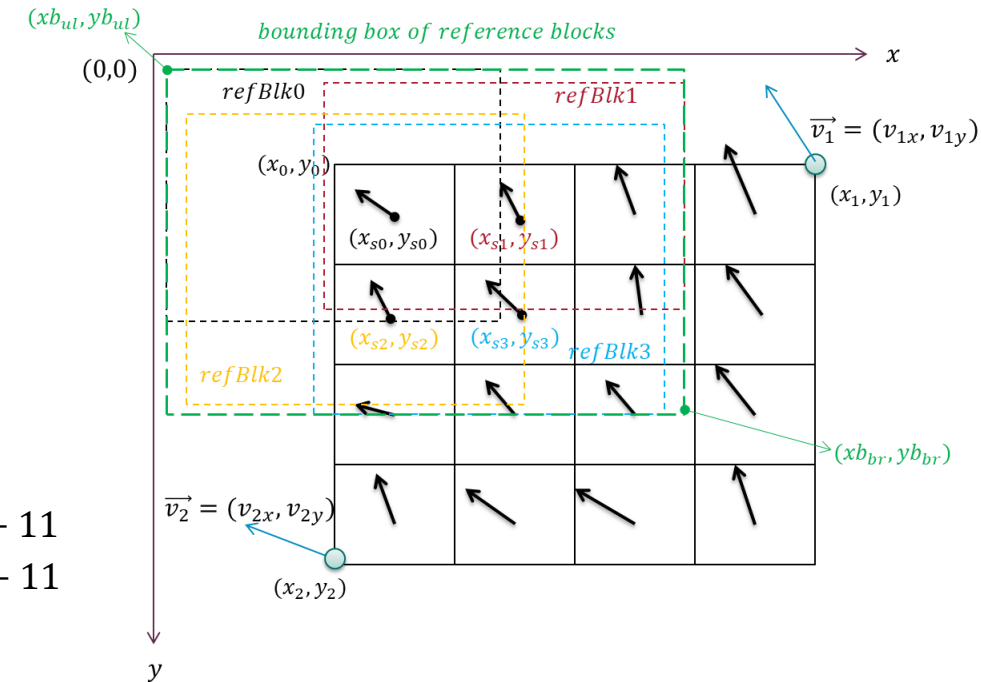
- Affine motion model $\begin{cases} v_x = ax + cy + e \\ v_y = bx + dy + f \end{cases}$
- The reference block bounding box size (bxW4, bxH4) of the 2x2 sub-block vectors

$$\begin{cases} bxW4 = \max(0, 4(1+a), 4c, 4(1+a) + 4c) - \min(0, 4(1+a), 4c, 4(1+a) + 4c) + 11 \\ bxH4 = \max(0, 4b, 4(1+d), 4b + 4(1+d)) - \min(0, 4b, 4(1+d), 4b + 4(1+d)) + 11 \end{cases}$$

- Pre-defined threshold: $Thred4 = (15 + \delta_x) * (15 + \delta_y)$
- If the following conditions are satisfied, the regular affine MC applies.

$$\begin{cases} bxW_4 * bxH_4 \leq Thred_4 & \text{for bi-directional affine mode} \\ bxW_4 * bxH_4 \leq 2 * Thred_4 & \text{for unidirectional affine mode} \end{cases}$$

Otherwise, all the sub-block vectors of the PU is set to a same one which is generated at the center point of the PU by using the affine motion model, single vector is used for the MC of affine coded PU.



Experimental Results

- Tests carried out (*setting* $\delta_x = \delta_y = 2$):
 - Test1: the encoder controls the affine motion estimation so that the fallback mode is never triggered in the bitstreams.
 - Test2: the encoder allows the use of fallback mode if the reference block bounding box sizes exceed the pre-defined thresholds
- Summary results:

Test 1

	Random Access Main 10				
	Over VTM4.0			EncT	DecT
	Y	U	V		
Class A1	0.02%	-0.10%	0.12%	91%	94%
Class A2	0.02%	0.00%	0.05%	96%	99%
Class B	0.01%	0.02%	0.09%	94%	93%
Class C	0.01%	0.00%	-0.05%	94%	96%
Class E					
Overall	0.01%	-0.01%	0.05%	94%	95%
Class D	0.00%	0.03%	0.02%	93%	97%
Class F (optional)	0.04%	0.06%	0.01%	92%	97%

	Low delay B Main10				
	Over VTM4.0			EncT	DecT
	Y	U	V		
Class A1					
Class A2					
Class B	0.02%	-0.10%	-0.08%	95%	105%
Class C	0.00%	0.19%	0.16%	93%	91%
Class E	-0.03%	0.33%	-0.16%	82%	87%
Overall	0.00%	0.10%	-0.02%	91%	96%
Class D	0.00%	-0.03%	-0.59%	101%	99%
Class F (optional)	-0.10%	-0.45%	-0.08%	99%	96%

Test 2

	Random Access Main 10				
	Over VTM4.0			EncT	DecT
	Y	U	V		
Class A1	0.00%	-0.03%	0.07%	93%	93%
Class A2	-0.02%	-0.11%	0.00%	88%	98%
Class B	-0.01%	-0.07%	0.03%	91%	92%
Class C	-0.01%	-0.08%	-0.08%	90%	92%
Class E					
Overall	-0.01%	-0.07%	0.00%	91%	93%
Class D	0.00%	-0.04%	-0.08%	89%	95%
Class F (optional)	-0.04%	-0.02%	-0.01%	95%	99%

	Low delay B Main10				
	Over VTM4.0			EncT	DecT
	Y	U	V		
Class A1					
Class A2					
Class B	-0.03%	-0.02%	-0.13%	92%	101%
Class C	-0.05%	0.10%	0.03%	93%	99%
Class E	0.08%	0.23%	-0.41%	89%	97%
Overall	-0.01%	0.08%	-0.15%	92%	100%
Class D	-0.01%	-0.19%	-0.66%	96%	118%
Class F (optional)	-0.18%	-0.15%	-0.37%	113%	97%

Memory Bandwidth Measurements (RA)

- Memory bandwidth measured by using a commercial MC cache model.
- No memory bandwidth impact has been observed by imposing the restrictions.
 - TCM_diff : Total cache misses (over all the frames coded), percentage increase relative to VTM4.0.
 - ABW_diff: Average memory bandwidth (over all the frames coded), percentage increase relative to VTM4.0.
 - MBW_diff : Worst case (Max) memory bandwidth (among all the frames coded), percentage increase relative to VTM4.0.

	Random Access Main 10							
	Over VTM-4.0							
	Y	U	V	TCM_diff	ABW_diff	MBW_diff	EncT	DecT
Class A1	0.02%	-0.10%	0.12%	-0.06%	-0.04%	-0.32%	91%	105%
Class A2	0.02%	0.00%	0.05%	-0.09%	-0.19%	0.32%	96%	112%
Class B	0.01%	0.02%	0.09%	-0.02%	0.00%	-0.19%	94%	104%
Class C	0.01%	0.00%	-0.05%	0.10%	0.09%	0.93%	94%	107%
Class E								
Overall	0.01%	-0.01%	0.05%	-0.03%	-0.03%	0.93%	94%	107%
Class D	0.00%	0.03%	0.02%	-0.04%	-0.02%	0.21%	93%	109%
Class F (optional)	0.04%	0.06%	0.01%	-0.06%	0.00%	0.62%	92%	110%

Table 3: Memory bandwidth measurement for Test 1 ($\delta_x = \delta_y = 2$)

	Random Access Main 10							
	Over VTM-4.0							
	Y	U	V	TCM_diff	ABW_diff	MBW_diff	EncT	DecT
Class A1	0.00%	-0.03%	0.07%	-0.02%	0.00%	0.00%	93%	104%
Class A2	-0.02%	-0.11%	0.00%	0.01%	0.00%	0.63%	88%	111%
Class B	-0.01%	-0.07%	0.03%	0.02%	0.04%	-0.93%	91%	108%
Class C	-0.01%	-0.08%	-0.08%	0.01%	0.07%	0.00%	90%	110%
Class E								
Overall	-0.01%	-0.07%	0.00%	0.01%	0.04%	0.63%	91%	108%
Class D	0.00%	-0.04%	-0.08%	0.00%	0.04%	0.21%	89%	110%
Class F (optional)	-0.04%	-0.02%	-0.01%	0.05%	0.11%	-0.31%	95%	109%

Table 4: Memory bandwidth measurement for Test 2 ($\delta_x = \delta_y = 2$)