



CREATING THE LIVING NETWORK™

JVET-N0236

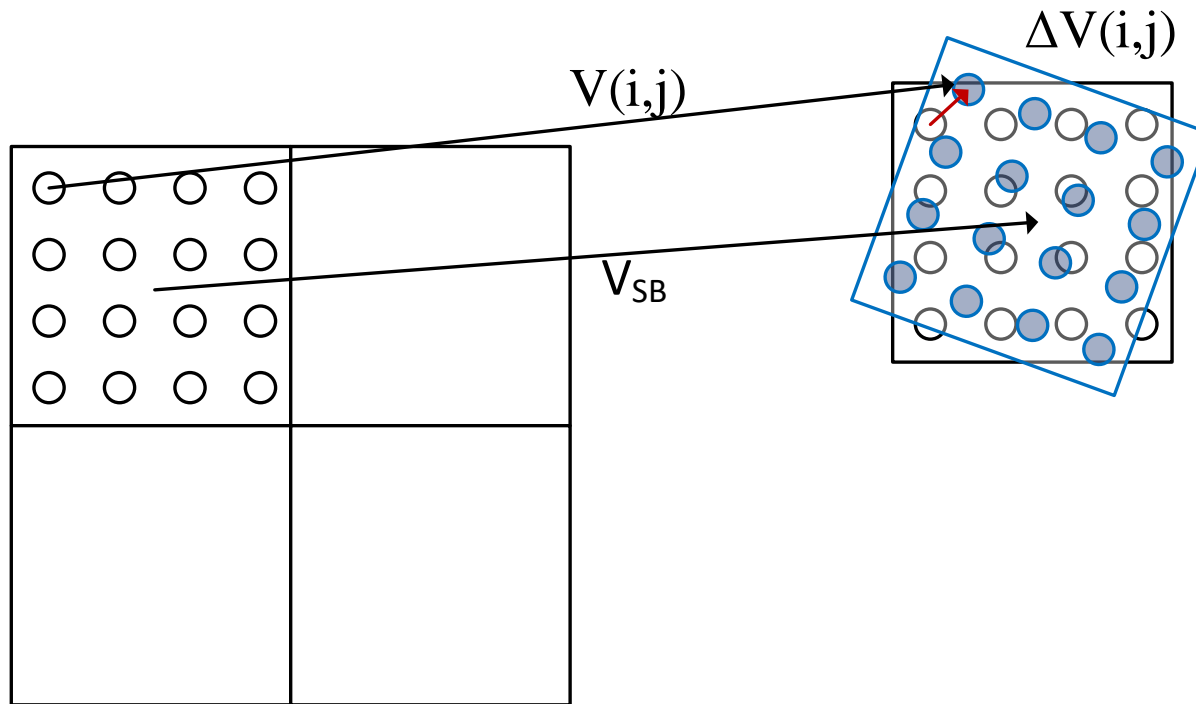
CE2-related: Prediction
refinement with optical flow for
affine mode

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Introduction

- Affine motion model parameters can be used to derive the motion vector of each pixel in a CU.
- The subblock based affine motion compensation is a trade-off between coding efficiency, complexity and memory access bandwidth. It loses prediction accuracy due to subblock-based prediction.

Proposed PROF



Proposed PROF

1. Affine subblock MC is performed as current VVC
2. Calculate spatial gradient using 3-tap filter [-1, 0, 1]
3. Calculate prediction refinement with optical flow

$$\Delta I(i, j) = g_x(i, j) * \Delta v_x(i, j) + g_y(i, j) * \Delta v_y(i, j)$$

$$\begin{cases} \Delta v_x(x, y) = c * x + d * y \\ \Delta v_y(x, y) = e * x + f * y \end{cases}$$

4. Add prediction refinement to the prediction

$$I'(i, j) = I(i, j) + \Delta I(i, j)$$

Experimental description

- Subblock prediction extended by padding with nearest integer reference sample
 - Test 1. sub-block size is 4x4
 - Test 2. sub-block size is 4x4 for uni- and 8x8 for bi-prediction
 - Test 3. = test 1 + affine sequences provided by Huawei
 - Test 6. sub-block size is 4x4 for uni- and 8x4 for bi-prediction
- Integer reference block before interpolation is extended by copying from adjacent sample from the reference block
 - Test 4. sub-block size is 4x4
 - Test 5. sub-block size is 4x4 for uni- and 8x8 for bi-prediction

Experimental results

Test 1. Affine sub-block size 4x4 test on CTC sequence

	Random Access Main 10					Low delay B Main10				
	Over VTM 4.0					Over VTM 4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.15%	0.05%	0.08%	102%	101%					
Class A2	-0.83%	0.41%	0.27%	104%	101%					
Class B	-0.61%	-0.27%	-0.07%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class C	-0.31%	-0.06%	-0.18%	103%	101%	-0.27%	-0.02%	-0.04%	102%	101%
Class E						-0.45%	0.08%	-0.40%	103%	101%
Overall	-0.48%	-0.02%	0.00%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class D	-0.57%	-0.36%	-0.31%	102%	101%	-0.51%	-0.61%	-1.21%	102%	102%
Class F	-0.88%	-0.37%	-0.44%	103%	101%	-1.40%	-1.13%	-0.87%	102%	101%

CatRobot -1.49%, Cactus -2.05%,
BQSquare -1.22%, SlideShow -2.98%

Experimental results

Test 2. Affine sub-block size 4x4 for uni-prediction and 8x8 for bi-prediction

	Random Access Main 10					Low delay B Main10				
	Over VTM 4.0					Over VTM 4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.13%	0.08%	0.15%	102%	100%	#VALUE! ! -0.15% -0.27% #VALUE! !	#VALUE! ! 0.12% 0.05% #VALUE! !	#VALUE! ! -0.07% 0.19% #VALUE! !	#VALUE! ! 100% 102% #VALUE! !	#NUM! ! 95% 97% #NUM! !
Class A2	-0.53%	0.65%	0.58%	102%	99%					
Class B	-0.46%	-0.10%	-0.07%	102%	101%					
Class C	-0.18%	0.01%	0.08%	102%	101%					
Class E										
Overall	-0.33%	0.12%	0.15%	102%	100%					
Class D	-0.35%	0.02%	-0.11%	101%	101%	#VALUE! !	#VALUE! !	#VALUE! !	#VALUE! !	#NUM! !
Class F	-0.62%	-0.14%	-0.13%	102%	101%					

Experimental results

Test 3. Affine Sequences using Test 1 condition

	Random Access Main 10			Low delay B Main10		
	Over VTM 4.0			Over VTM 4.0		
	Y	U	V	Y	U	V
BlueSkyPart	-1.68%	-0.74%	-0.65%	-1.66%	-0.75%	-0.65%
JetParts	-0.39%	-0.05%	-0.20%	-0.36%	-0.08%	-0.24%
ShieldsPart	-1.01%	-0.37%	-0.39%	-1.02%	-0.36%	-0.37%
SpincalendarPart	-2.59%	-1.55%	-1.83%	-2.62%	-1.49%	-1.83%
StationKtaPart	-2.30%	-0.46%	-0.08%	-2.06%	-0.47%	-0.10%
TractorPart	-2.62%	-0.25%	-0.34%	-2.55%	-0.28%	-0.36%
Overall	-1.77%	-0.57%	-0.58%	-1.02%	-0.40%	-0.42%

Experimental results

Test 4. Affine sub-block size 4x4 for uni- and bi-prediction

	Random Access Main 10					Low delay B Main10				
	Over VTM 4.0					Over VTM 4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.17%	-0.10%	0.15%	105%	102%					
Class A2	-0.90%	0.29%	0.30%	107%	103%					
Class B	-0.63%	-0.27%	-0.17%	105%	103%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class C	-0.35%	-0.04%	-0.10%	105%	102%	-0.27%	0.09%	0.10%	104%	103%
Class E	-	-	-	-	-	-0.35%	-0.10%	-0.46%	107%	103%
Overall	-0.52%	-0.06%	0.01%	105%	102%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class D	-0.59%	-0.19%	-0.23%	105%	102%	-0.53%	0.34%	-0.36%	103%	105%
Class F	-0.98%	-0.48%	-0.45%	105%	101%	-1.43%	-1.46%	-1.23%	103%	102%

Experimental results

Test 5. Affine sub-block size 4x4 for uni-prediction and 8x8 for bi-prediction

(integer reference block before interpolation is extended by
copying from adjacent sample form the reference block)

	Random Access Main 10					Low delay B Main10				
	Over VTM 4.0					Over VTM 4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.15%	-0.03%	0.18%	103%	100%					
Class A2	-0.62%	0.63%	0.55%	104%	100%					
Class B	-0.50%	-0.09%	0.01%	103%	102%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class C	-0.20%	0.10%	-0.02%	103%	101%	-0.21%	0.14%	-0.13%	101%	95%
Class E						-0.20%	-0.09%	-0.73%	103%	98%
Overall	-0.38%	0.12%	0.14%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class D	-0.39%	0.10%	0.12%	102%	102%	-0.17%	0.25%	-0.79%	102%	101%
Class F	-0.74%	-0.21%	-0.24%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!

Experimental results

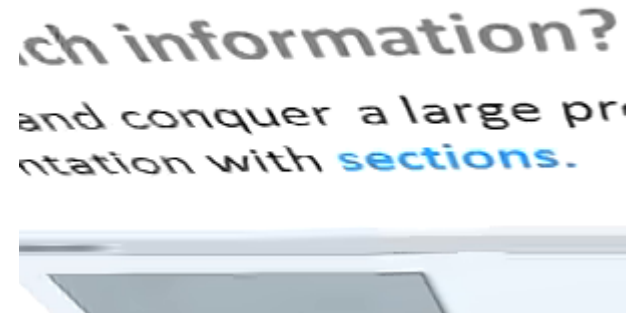
**Test 6. Affine sub-block size 4x4 for uni-prediction and
8x4 for bi-prediction**

	Random Access Main 10					Low delay B Main10				
	Over VTM 4.0					Over VTM 4.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Class A1	-0.14%	0.10%	0.10%	103%	100%					
Class A2	-0.68%	0.35%	0.44%	103%	100%					
Class B	-0.53%	-0.22%	-0.01%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class C	-0.22%	-0.03%	-0.03%	103%	102%	-0.20%	0.12%	0.15%	101%	95%
Class E						-0.27%	-0.26%	-0.42%	103%	98%
Overall	-0.40%	0.01%	0.10%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!
Class D	-0.40%	0.00%	-0.14%	102%	102%	-0.29%	-0.43%	-1.04%	102%	102%
Class F	-0.70%	-0.15%	-0.20%	103%	101%	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#NUM!

Subjective improvement



PROF off



PROF on

Summary

- Propose pixel level prediction refinement with optical flow for affine mode
 - Apply after affine mode
 - Low complexity
- Performance
 - -0.48% with 103% ET and 101% DT over VTM 4.0 with 4x4 subblock
 - -0.33% over VTM4.0 with 8x8 subblock, while reduce worst-case bandwidth.
- Subjective improvements
- Propose for study in CE

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