

JVET-L0646

CE4-related: Generalized bi-prediction improvements combined from JVET-L0197 and JVET-L0296

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Overall Summary

- Proposed one combined solution based on JVET-L0197 and JVET-L0296 to further improve the generalized bi-prediction (GBi) performance
 - GBi encoder bug fix
 - Five encoder speed-up methods
 - CU size constraint for GBi
- Reported BD-rate number and encoding/decoding time

		Over BMS2.1 with VTM configuration		
		Y BD-rate	Enc. Time	Dec. Time
GBi in BMS2.1 version	RA	-0.68%	115%	102%
Proposed GBi	RA	-0.66%	106%	99%

Introduction

- Current GBi design in BMS2.1
 - Bi-prediction is generated with one weighting parameter signaled for the coding unit

$$P_{bi-pred} = ((8 - w) * P_0 + w * P_1 + 4) \gg 3$$

- Five weights for low delay pictures: $\{-2/8, 3/8, 4/8, 5/8, 10/8\}$
- Three weights for non-low-delay pictures: $\{3/8, 4/8, 5/8\}$
- GBi weight is determined based on RD cost
- GBi is also combined with other coding tools, such as affine motion models and adaptive motion vector resolution (AMVR)
- GBi in BMS2.1: 0.68% gain with 115% encoding time in RA

Encoder Bugfix for Affine ME with GBi Enabled

- Affine ME with multiple GBi weights
 - Perform affine ME with equal GBi weight first, and store those uni-prediction affine MVs
 - For unequal GBi weight, affine uni-prediction search reuses those stored affine MVs found for equal GBi weight
- BMS2.1 encoder stores uni-prediction affine MVs of 6-parameter and 4-parameter affine models to the same buffer
 - Those stored 4-parameter affine MVs may be overwritten by 6-parameter affine MVs and may be reused for 4-parameter affine ME for unequal GBi weights.
- The fix is to store uni-prediction affine MVs for equal GBi weight to different buffers according to affine type
 - The encoder reuses corresponding stored affine MVs based on affine type

Encoder Speed-up Methods

- 1) Skipping affine motion estimation for some GBi weights conditionally
 - The encoder will skip affine ME for all unequal GBi weights if explicit affine mode is not selected as the best mode after the encoding with equal GBi weight
- 2) Reducing the number of weights for RD cost checking for low-delay pictures in the encoding for 1-pel and 4-pel MVD precision
 - Order those unequal weights according to their RD cost in 1/4-pel MVD precision; Only the first two weights with the smallest RD costs, together with equal GBi weight, will be evaluated during the encoding in 1-pel and 4-pel MVD precisions

Encoder Speed-up Methods

- 3) Conditionally skipping bi-prediction search when the L0 and L1 reference pictures are the same
 - Two reference pictures in bi-prediction are the same
 - Temporal layer is greater than 1
 - The MVD precision is 1/4-pel
- 4) Skipping RD cost checking for unequal GBi weight based on temporal layer and the POC distance between reference picture and current picture
 - Temporal layer is equal to 4
 - POC distance of reference picture and current picture is equal to 1

Encoder Speed-up Methods

5) Changing floating-point calculation to fixed-point calculation for unequal GBi weight during ME

- The target for bi-prediction search is modified for unequal weights as

$$T = ((O \ll 3) - w * P_1) * (1/(8 - w))$$

w is the weight for list-1 prediction; the term $(1/(8 - w))$ is stored in floating point precision.

- Changing to fixed-point calculation

$$T = (O * a_1 - P_1 * a_2 + round) \gg N$$

CU Size Constraint

- In advanced motion vector prediction (AMVP) mode, if bi-prediction is used and the CU size is smaller than 256 luma samples, then GBi is disabled without any signaling

Simulation Results

Random Access Main 10					
Over VTM-2.1					
	Y	U	V	EncT	DecT
Class A1	-0.59%	-0.93%	-0.80%	105%	101%
Class A2	-0.73%	-1.06%	-0.92%	105%	101%
Class B	-0.88%	-0.93%	-0.95%	107%	102%
Class C	-0.38%	-0.31%	-0.32%	106%	97%
Class E					
Overall	-0.66%	-0.79%	-0.75%	106%	100%
Class D	-0.38%	-0.28%	-0.22%	106%	101%
Class F (optional)	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!

Low delay B Main10					
Over VTM-2.1					
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	-0.44%	-0.56%	-0.66%	104%	97%
Class C	-0.28%	-0.07%	0.18%	105%	98%
Class E	-0.14%	-0.50%	-0.06%	106%	99%
Overall	-0.31%	-0.38%	-0.23%	105%	98%
Class D	-0.10%	0.40%	-0.41%	106%	99%
Class F (optional)	#VALUE!	#VALUE!	#VALUE!	#DIV/0!	#DIV/0!

Conclusions

- Proposed one combined solution based on JVET-L0197 and JVET-L0296 to further improve the GBi performance.
 - Include encoder bug fix, CU size constraints, and several encoding algorithm improvements
 - The GBi encoding time reduced with small coding efficiency loss.
 - GBi has negligible impact on decoding complexity

		Over BMS2.1 with VTM configuration		
		Y BD-rate	Enc. Time	Dec. Time
Generalized Bi-prediction	RA	-0.66%	106%	99%

- Thank Foxconn for cross-checking the results

Thank You