

JVET-L0082: CE2.2.1 and CE2.2.2 ALF coefficient coding and range constraints

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Overall Summary

- In CE2.2.1, ALF coefficients are coded with 0-th order exp-Golomb codes.
- In CE2.2.2, the ranges of ALF coefficients are limited to achieve 10-bit representation
 - Reduce the multiplier input from 15bits and 11bits to 10bits for center and non-center coefficients, respectively
- Reported BD-rate number and encoding/decoding time:

		Over VTM-2.0.1		
		Y BD-rate	Enc. Time	Dec. Time
CE2.2.1	AI	0.08%	100%	101%
	RA	0.14%	100%	100%
	LB	0.12%	100%	100%
CE2.2.2	AI	0.00%	100%	100%
	RA	0.00%	100%	101%
	LB	-0.01%	100%	100%

CE2.2.1 Proposed Methods

- ALF coefficient coding in VTM2.0.1
 - Use adaptive k-th order exp-Golomb coding.
 - Need to derive the value of “k”, and signal the base of the k value and the flag indicating increasing the k value for each coefficient position-based group.
- In CE2.2.1
 - Both luma and chroma ALF coefficients are mapped from signed values to unsigned values first and coded by using 0-th order exp-Golomb codes.

CE2.2.2 Proposed Methods

- ALF coefficient range in VTM2.0.1
 - The precision in the fractional part is 9-bits
 - The allowed integer representation range of non-center ALF coefficients is $[-614, 614]$.
 - The allowed integer representation range of non-center ALF coefficients is $[-14224, 15248]$, since the filter gain is kept to 512
 - The number of required bits to represent a non-center coefficient and a center coefficient is 11 and 15, respectively.
 - Need multipliers with 11bits x 10bits for non center coefficients and one multiplier with 15bits x 10bits for center coefficient

CE2.2.2 Proposed Methods

- CE2.2.2
 - The real value range of the non-center coefficient and the center coefficient is set to $[-1.0, 1.0)$ and $[0.0, 2.0)$, respectively.
 - Center coefficient is unsigned, while non-center coefficients are signed.
 - The input bitdepth of multipliers are reduced to 10bits

	The real value range	Number of fractional bit	Number of required bits
Non-center coefficients	$[-1.0, 1.0)$	9 (same as VTM2.0.1)	Reduced from 11 to 10 bit
The center coefficient	$[0.0, 2.0)$	9 (same as VTM2.0.1)	Reduced from 15 to 10 bit

Simulation Results of CE2.2.1

	All Intra Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	0.04%	0.02%	0.02%	100%	101%
Class A2	0.03%	0.02%	0.02%	100%	100%
Class B	0.06%	0.02%	0.03%	101%	101%
Class C	0.12%	0.04%	0.04%	100%	100%
Class E	0.16%	0.08%	0.09%	100%	100%
Overall	0.08%	0.04%	0.04%	100%	101%
Class D	0.12%	0.09%	0.11%	100%	101%
Class F (optional)	0.07%	0.02%	0.03%	100%	100%
	Random Access Main 10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	0.13%	0.14%	0.05%	101%	100%
Class A2	0.13%	0.03%	0.03%	101%	102%
Class B	0.16%	0.15%	0.10%	100%	99%
Class C	0.14%	0.29%	0.11%	100%	100%
Class E					
Overall	0.14%	0.16%	0.08%	100%	100%
Class D	0.18%	0.39%	0.43%	100%	99%
Class F (optional)	0.05%	0.05%	0.06%	100%	99%
	Low delay B Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.15%	0.09%	-0.23%	101%	102%
Class C	0.17%	0.03%	-0.01%	100%	100%
Class E	-0.01%	-0.63%	0.09%	100%	97%
Overall	0.12%	-0.11%	-0.08%	100%	100%
Class D	0.17%	0.84%	0.25%	100%	100%
Class F (optional)	0.03%	0.58%	0.85%	101%	100%

Simulation Results of CE2.2.2

	All Intra Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	0.01%	0.00%	0.00%	101%	100%
Class A2	0.00%	0.00%	0.00%	101%	100%
Class B	0.00%	0.00%	0.00%	100%	100%
Class C	0.00%	0.00%	0.00%	100%	100%
Class E	0.00%	0.00%	0.00%	100%	100%
Overall	0.00%	0.00%	0.00%	100%	100%
Class D	0.00%	0.00%	0.00%	100%	100%
Class F (optional)	0.00%	0.00%	0.00%	100%	100%

	Random Access Main 10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	0.01%	0.01%	-0.03%	100%	101%
Class A2	0.00%	0.01%	0.00%	100%	103%
Class B	0.00%	-0.01%	0.01%	100%	101%
Class C	0.00%	0.00%	0.00%	100%	101%
Class E					
Overall	0.00%	0.00%	0.00%	100%	101%
Class D	0.00%	0.01%	0.00%	100%	100%
Class F (optional)	-0.01%	-0.02%	-0.05%	100%	99%

	Low delay B Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.01%	-0.08%	-0.08%	100%	103%
Class C	-0.01%	-0.06%	-0.05%	100%	99%
Class E	-0.03%	0.06%	0.12%	100%	97%
Overall	-0.01%	-0.04%	-0.02%	100%	100%
Class D	0.00%	-0.01%	0.09%	100%	100%
Class F (optional)	-0.11%	0.27%	0.14%	100%	101%

Table2. Results of CE2.2.2: Reduced ALF coefficient ranges; center: [0.0, 2.0); non-center: [-1.0, 1.0)

Conclusions

- ALF coefficient coding with 0-th order exp-Golomb coding suffers less than 0.15% BD-rate increase in comparison with adaptive k-th order exp-Golomb codes.
- 10-bit representation for ALF coefficients with the reduced real value ranges does not result in any coding loss.
 - Reduce the multiplier input from 15bits and 11bits to 10bits

- Reported BD-rate number and encoding/decoding time:

		Over VTM-2.0.1		
		Y BD-rate	Enc. Time	Dec. Time
CE2.2.1	AI	0.08%	100%	101%
	RA	0.14%	100%	100%
	LB	0.12%	100%	100%

		Over VTM-2.0.1		
		Y BD-rate	Enc. Time	Dec. Time
CE2.2.2	AI	0.00%	100%	100%
	RA	0.00%	100%	101%
	LB	-0.01%	100%	100%

- Thank Qualcomm for cross-checking the results.

