

CE7-related: Simplification of coding transform coefficient levels (JVET-P0170)

Shih-Ta Hsiang, Tzu-Der Chuang, Yu-Wen Huang, and Shawmin Lei

Presented by Tzu-Der Chuang

Overall Summary

- Proposing a simplified method for deriving the variable ZeroPos[n] associated with the reconstruction of the coefficient level value from the decoded syntax element dec_abs_level
- Simplifying the coding transform coefficient levels while removing 96 look-up table entries
- Summary of overall BD bitrate results under the common test conditions (CTCs) as follows:

All Intra (AI)			Random Access (RA)			Low Delay B (LB)		
Y	Cb	Cr	Y	Cb	Cr	Y	Cb	Cr
0.01%	0.00%	0.00%	0.00%	0.03%	0.06%	0.00%	0.14%	-0.08%

Coding `dec_abs_level` in VVC Draft 6

- After the remaining available context bins is less than 4, the absolute value of the transform coefficient level at the scanning position `n` is signalled by the syntax element `dec_abs_level[n]`
- `dec_abs_level` is coded using the Golomb-Rice code with the selected Rice parameter **cRiceParam** determined by the adjusted sum of the absolute level values of five neighboring coefficients (indicated by **locSumAbs**)
- The variable **ZeroPos**[`n`] indicates the assigned syntax value for the zero level value for `dec_abs_level[n]`, determined by the dependent quantization state **QState** and the local sum `locSumAbs`

Derivation of ZeroPos[n] in VVC Draft 6

- The absolute value of a transform coefficient level at location (xC, yC) $\text{AbsLevel}[xC][yC]$ is derived as follow:
 - If $\text{dec_abs_level}[n]$ is equal to $\text{ZeroPos}[n]$, $\text{AbsLevel}[xC][yC]$ is set equal to 0.
 - Otherwise, if $\text{dec_abs_level}[n]$ is less than $\text{ZeroPos}[n]$, $\text{AbsLevel}[xC][yC]$ is set equal to $\text{dec_abs_level}[n] + 1$;
 - Otherwise ($\text{dec_abs_level}[n]$ is greater than $\text{ZeroPos}[n]$), $\text{AbsLevel}[xC][yC]$ is set equal to $\text{dec_abs_level}[n]$.
- The Rice parameter cRiceParam and the variable $\text{ZeroPos}[n]$ are derived according to the Table below, where the variable s is set equal to $\text{Max}(0, \text{QState} - 1)$

trafoSkip	s	locSumAbs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0		cRiceParam	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2
1		cRiceParam	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
	0	ZeroPos[n]	0	0	0	0	0	1	2	2	2	2	2	2	4	4	4	4
	1	ZeroPos[n]	1	1	1	1	2	3	4	4	4	6	6	6	8	8	8	8
	2	ZeroPos[n]	1	1	2	2	2	3	4	4	4	6	6	6	8	8	8	8
		locSumAbs	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0		cRiceParam	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
1		cRiceParam	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	0	ZeroPos[n]	4	4	4	4	4	4	4	8	8	8	8	8	16	16	16	16
	1	ZeroPos[n]	4	4	12	12	12	12	12	12	12	12	16	16	16	16	16	16
	2	ZeroPos[n]	8	8	12	12	12	12	12	12	12	16	16	16	16	16	16	16

Proposed Simplification for Deriving ZeroPos

- Motivation: the adaptively selected Rice parameter cRiceParam according to locSumAbs can reflect the local activities
- Propose to derive the variable ZeroPos[n] from the dependent quantization state QState and the selected Rice parameter cRiceParam without using the look-up table as follow:

$$\text{ZeroPos}[n] = (QState < 2 ? 1 : 2) \ll \text{cRiceParam}$$

- Can remove 96 look-up table entries for deriving ZeroPos

trafoSkip	s	locSumAbs	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0		cRiceParam	0	0	0	0	0	0	0	1	1	1	1	1	1	1	2	2
1		cRiceParam	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
	0	ZeroPos[n]	0	0	0	0	0	1	2	2	2	2	2	2	4	4	4	4
	1	ZeroPos[n]	1	1	1	1	2	3	4	4	4	6	6	6	8	8	8	8
	2	ZeroPos[n]	1	1	2	2	2	3	4	4	4	6	6	6	8	8	8	8
		locSumAbs	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0		cRiceParam	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
1		cRiceParam	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	0	ZeroPos[n]	4	4	4	4	4	4	4	8	8	8	8	8	16	16	16	16
	1	ZeroPos[n]	4	4	12	12	12	12	12	12	12	12	16	16	16	16	16	16
	2	ZeroPos[n]	8	8	12	12	12	12	12	12	12	16	16	16	16	16	16	16

Experimental Results

- Anchor: VTM-6.0 under the common test conditions
- Test 1 (left): Proposal over standard QPs 22, 27, 32, 37
- Test 2 (right): Proposal over low QPs 2, 7, 12, 17

All Intra Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	0.01%	-0.03%	103%	103%
Class A2	0.01%	0.01%	0.02%	103%	110%
Class B	0.00%	0.01%	-0.04%	102%	103%
Class C	0.01%	-0.06%	0.05%	99%	99%
Class E	0.01%	0.03%	0.02%	99%	99%
Overall	0.01%	0.00%	0.00%	101%	102%
Class D	0.01%	0.15%	0.04%	99%	96%
Class F	0.01%	-0.05%	0.04%	98%	99%

Random access Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.04%	0.04%	105%	101%
Class A2	0.02%	0.10%	0.02%	104%	98%
Class B	-0.02%	-0.02%	0.02%	101%	97%
Class C	-0.02%	0.07%	0.14%	99%	99%
Overall	0.00%	0.03%	0.06%	102%	99%
Class D	-0.02%	-0.35%	-0.12%	100%	105%
Class F	0.01%	-0.04%	-0.05%	100%	104%

Low delay B Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class B	0.00%	-0.02%	-0.02%	101%	100%
Class C	0.01%	-0.07%	0.05%	102%	102%
Class E	-0.01%	0.69%	-0.36%	101%	102%
Overall	0.00%	0.14%	-0.08%	101%	101%
Class D	-0.04%	-0.28%	0.07%	100%	103%
Class F	0.05%	0.21%	0.73%	99%	104%

All Intra Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	-0.02%	0.03%	0.06%	98%	96%
Class A2	-0.04%	0.01%	0.01%	98%	96%
Class B	0.01%	0.03%	0.06%	102%	103%
Class C	0.03%	0.05%	0.09%	102%	102%
Class E	0.02%	0.03%	0.03%	102%	102%
Overall	0.00%	0.03%	0.05%	101%	100%
Class D	0.03%	0.03%	0.10%	101%	100%
Class F	0.04%	0.03%	0.03%	101%	102%

Random access Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class A1	-0.03%	0.00%	0.00%	101%	100%
Class A2	-0.08%	-0.06%	-0.05%	101%	97%
Class B	-0.03%	0.00%	-0.01%	101%	101%
Class C	-0.04%	-0.01%	-0.02%	101%	97%
Overall	-0.04%	-0.01%	-0.02%	101%	99%
Class D	-0.03%	0.01%	0.07%	99%	99%
Class F	-0.06%	-0.15%	-0.17%	100%	98%

Low delay B Main10					
Over VTM-6.0					
	Y	U	V	EncT	DecT
Class B	-0.04%	-0.02%	0.00%	99%	97%
Class C	-0.06%	0.02%	-0.02%	96%	94%
Class E	0.00%	-0.01%	0.04%	97%	96%
Overall	-0.04%	0.00%	0.00%	98%	96%
Class D	-0.03%	0.02%	0.01%	98%	98%
Class F	-0.10%	-0.11%	-0.21%	101%	100%

Conclusion

- The proposed simplification for deriving the variable ZeroPos[n] has negligible impacts on overall BD bitrate results

	All Intra (AI)			Random Access (RA)			Low Delay B (LB)		
	Y	Cb	Cr	Y	Cb	Cr	Y	Cb	Cr
CTC QPs	0.01%	0.00%	0.00%	0.00%	0.03%	0.06%	0.00%	0.14%	-0.08%
low QPs	0.00%	0.03%	0.05%	-0.04%	-0.01%	-0.02%	-0.04%	0.00%	0.00%

- Recommend the adoption of the proposed method into VVC Draft 7
- Thank Huawei for cross checking this contribution