

CE3-related: Unified rice parameter derivation of transform skip residual (JVET-Q0145)

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Introduction

In TSRC of VTM7.0, rice parameter is fixed to be 1, whereas rice parameter is derived using sum of 5 neighbor coefficients in RRC.

To improve coding gain of lossless coding and lossy coding, it is proposed that rice parameter of TSRC is calculated using sum of 2 neighbor coefficients in a unified way with RRC.

Table 1: Comparison of rice parameter derivation method: RRC, TSRC(proposal), and CE 3-1.2

	RRC (VTM7.0)	TSRC (proposal)	CE3-1.2
Number of reference coefficients used	5	2	2
Component assigned to Rice parameter Table	Sum – 5*baseLevel	(Sum–2*baseLevel)<<1	Sum + offset
Rice parameter Table	A	A	B

Table A = { 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3, 3, 3, 3 }

Table B = { 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3 }

offset = (baseLevel == 10 ? -8 : (baseLevel == 0 ? 0 : -4))

Proposed rice parameter derivation method:

1. Same Rice parameter table is used both for RRC and TSRC
2. Calculation method of sum variable is same as RRC, but refers to 2 coefficients only
3. Sum variable is doubled to compensate for the difference in the number of reference coefficients, i.e. 5 for RRC and 2 for TSRC.

Simulation results

Lossless

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	VTM7.0	proposal		VTM7.0	proposal		VTM7.0	proposal	
Class A1	2.2	2.3	-4.38%	2.2	2.3	-4.44%			
Class A2	1.6	1.7	-8.29%	1.7	1.8	-6.77%			
Class B	2.2	2.2	-3.36%	2.3	2.4	-1.49%	2.3	2.4	-1.50%
Class C	1.9	2.0	-4.76%	2.4	2.5	-2.45%	2.4	2.5	-2.30%
Class D	1.9	2.0	-5.26%	2.8	2.8	-2.61%	2.7	2.8	-2.44%
Class E	2.8	2.9	-4.59%				3.1	3.2	-3.60%
Class F	5.3	5.5	-3.81%	33.7	34.8	-3.00%	50.7	51.9	-2.74%
TGM	11.8	12.3	-3.80%	107.1	115.8	-6.00%	124.9	135.7	-5.98%
Overall	2.1	2.2	-4.87%	2.2	2.3	-3.39%	2.6	2.6	-2.29%
Enc Time[%]	100%			102%			99%		
Dec Time[%]	102%			101%			104%		

In all sequences, large coding gain is obtained.

Simulation results

CTC

	All Intra Main10				
	Over VTM-7.0				
	Y	U	V	EncT	DecT
Class A1	-0.01%	-0.03%	0.03%	99%	98%
Class A2	0.00%	0.00%	-0.01%	99%	98%
Class B	0.00%	0.03%	-0.10%	101%	101%
Class C	-0.03%	0.03%	0.01%	100%	100%
Class E	0.00%	0.01%	-0.07%	100%	102%
Overall	-0.01%	0.01%	-0.03%	100%	100%
Class D	-0.06%	0.07%	-0.05%	100%	100%
Class F	-0.14%	-0.15%	0.04%	100%	99%
TGM	-0.36%	-0.29%	-0.34%	99%	100%

In all sequences, minor coding gain is observed.

Random Access Main 10						Low delay B Main10					
Over VTM-7.0						Over VTM-7.0					
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	0.00%	-0.01%	0.02%	100%	100%	Class A1					
Class A2	-0.04%	-0.06%	-0.01%	100%	99%	Class A2					
Class B	0.01%	-0.04%	0.06%	100%	100%	Class B	-0.01%	-0.32%	-0.20%	100%	98%
Class C	0.00%	-0.02%	0.00%	100%	99%	Class C	0.00%	-0.29%	-0.15%	100%	99%
Class E						Class E	-0.07%	0.44%	-0.36%	100%	99%
Overall	0.00%	-0.04%	0.02%	100%	100%	Overall	-0.02%	-0.12%	-0.22%	100%	99%
Class D	-0.05%	-0.17%	-0.03%	100%	99%	Class D	-0.01%	-0.09%	-0.48%	100%	99%
Class F	-0.15%	0.01%	-0.05%	100%	99%	Class F	-0.15%	-0.47%	0.01%	100%	100%
TGM	-0.18%	-0.20%	-0.19%	100%	99%	TGM	-0.25%	-0.36%	-0.35%	100%	99%

Simulation results

LowQP

	All Intra Main10				
	Over VTM-7.0(100Frm,4K,LowQP)				
	Y	U	V	EncT	DecT
Class A1	-0.04%	-0.03%	-0.04%	100%	100%
Class A2	0.00%	-0.02%	-0.02%	100%	99%
Class B	-0.03%	-0.06%	-0.09%	99%	99%
Class C	-0.13%	-0.14%	-0.13%	99%	99%
Class E	-0.18%	-0.30%	-0.39%	100%	100%
Overall	-0.07%	-0.11%	-0.13%	100%	99%
Class D	-0.15%	-0.18%	-0.18%	100%	100%
Class F	-1.30%	-0.74%	-0.72%	99%	99%
TGM	-1.17%	-1.04%	-1.03%	100%	98%

In all sequences, coding gain is observed.
And screen contents have interesting coding gain.

	Random Access Main 10				
	Over VTM-7.0(100Frm,4K,LowQP)				
	Y	U	V	EncT	DecT
Class A1	-0.03%	-0.03%	-0.04%	100%	99%
Class A2	0.00%	-0.01%	0.00%	100%	99%
Class B	0.00%	-0.02%	-0.04%	96%	94%
Class C	-0.05%	-0.05%	-0.06%	103%	98%
Class E					
Overall	-0.02%	-0.03%	-0.04%	99%	97%
Class D	-0.09%	-0.01%	-0.17%	97%	95%
Class F	-1.63%	-0.59%	-0.68%	99%	97%
TGM	-1.83%	-1.06%	-1.03%	106%	105%

	Low delay B Main10				
	Over VTM-7.0(100Frm,4K,LowQP)				
	Y	U	V	EncT	DecT
Class A1					
Class A2					
Class B	0.01%	-0.02%	-0.01%	100%	100%
Class C	-0.03%	-0.01%	0.01%	100%	100%
Class E	-0.05%	0.00%	0.00%	100%	100%
Overall	-0.02%	-0.01%	0.00%	100%	100%
Class D	-0.05%	-0.01%	-0.20%	100%	100%
Class F	-0.58%	-0.50%	-0.57%	100%	99%
TGM	-1.02%	-0.69%	-0.69%	101%	100%

Simulation results over CE3-1.2 (Information)

Lossless

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	CE3-1.2	proposal		CE3-1.2	proposal		CE3-1.2	Proposal	
Class A1	2.3	2.3	-0.86%	2.3	2.3	-0.86%			
Class A2	1.7	1.7	-1.52%	1.8	1.8	-1.45%			
Class B	2.2	2.2	-0.27%	2.4	2.4	-0.07%	2.4	2.4	-0.08%
Class C	2.0	2.0	-0.44%	2.5	2.5	0.01%	2.5	2.5	0.04%
Class D	2.0	2.0	-0.53%	2.8	2.8	-0.02%	2.8	2.8	0.03%
Class E	2.9	2.9	-0.16%				3.2	3.2	0.06%
Class F	5.5	5.5	-0.15%	34.8	34.8	-0.03%	52.1	51.9	0.10%
TGM	12.3	12.3	-0.01%	115.7	115.8	-0.05%	136.0	135.7	0.20%
Overall	2.2	2.2	-0.60%	2.3	2.3	-0.48%	2.6	2.6	-0.01%
Enc Time[%]	#NUM!			#NUM!			#NUM!		
Dec Time[%]	#NUM!			#NUM!			#NUM!		

For AI and RA, coding gain is observed.

Simulation results over CE3-1.2 (Information)

CTC

	All Intra Main10				
	Over CE3-1.2				
	Y	U	V	EncT	DecT
Class A1	0.00%	0.00%	-0.01%	#NUM!	#NUM!
Class A2	0.00%	0.00%	0.01%	#NUM!	#NUM!
Class B	0.00%	0.00%	-0.05%	#NUM!	#NUM!
Class C	0.00%	0.02%	-0.05%	#NUM!	#NUM!
Class E	0.00%	0.04%	0.00%	#NUM!	#NUM!
Overall	0.00%	0.01%	-0.02%	#NUM!	#NUM!
Class D	0.01%	0.06%	0.06%	#NUM!	#NUM!
Class F	0.03%	0.06%	0.10%	#NUM!	#NUM!
TGM	0.05%	0.05%	0.03%	#NUM!	#NUM!

No coding loss over CE3-1.2.

		Random Access Main 10					Low delay B Main10					
		Over CE3-1.2					Over CE3-1.2					
		Y	U	V	EncT		DecT	Y	U	V	EncT	DecT
Class A1		0.00%	0.00%	-0.01%	#NUM!	#NUM!	Class A1					
Class A2		0.01%	-0.01%	-0.04%	#NUM!	#NUM!	Class A2					
Class B		-0.01%	0.01%	0.00%	#NUM!	#NUM!	Class B	0.01%	-0.02%	-0.10%	#NUM!	#NUM!
Class C		0.02%	0.10%	0.11%	#NUM!	#NUM!	Class C	-0.01%	-0.11%	0.08%	#NUM!	#NUM!
Class E					#NUM!	#NUM!	Class E	-0.01%	0.05%	0.11%	#NUM!	#NUM!
Overall		0.00%	0.03%	0.02%	#NUM!	#NUM!	Overall	0.00%	-0.03%	0.01%	#NUM!	#NUM!
Class D		-0.03%	-0.10%	0.02%	#NUM!	#NUM!	Class D	0.01%	-0.87%	0.27%	#NUM!	#NUM!
Class F		0.03%	0.02%	0.07%	#NUM!	#NUM!	Class F	-0.01%	-0.18%	-0.43%	#NUM!	#NUM!
TGM		0.09%	0.02%	-0.01%	#NUM!	#NUM!	TGM	0.01%	-0.09%	-0.17%	#NUM!	#NUM!

Simulation results over CE3-1.2 (Information)

LowQP

	All Intra Main10				
	Over CE3-1.2(100Frm,4K,LowQP)				
	Y	U	V	EncT	DecT
Class A1	0.01%	0.00%	0.00%	#NUM!	#NUM!
Class A2	0.00%	-0.01%	0.00%	#NUM!	#NUM!
Class B	0.00%	-0.01%	-0.01%	#NUM!	#NUM!
Class C	-0.03%	-0.01%	-0.02%	#NUM!	#NUM!
Class E	-0.01%	0.00%	-0.01%	#NUM!	#NUM!
Overall	0.00%	-0.01%	-0.01%	#NUM!	#NUM!
Class D	-0.05%	-0.04%	-0.05%	#NUM!	#NUM!
Class F	0.03%	0.07%	0.04%	#NUM!	#NUM!
TGM	0.18%	0.18%	0.19%	#NUM!	#NUM!

No coding loss from ClassA to ClassE.

	Random Access Main 10						Low delay B Main10				
	Over CE3-1.2(100Frm,4K,LowQP)						Over CE3-1.2(100Frm,4K,LowQP)				
	Y	U	V	EncT	DecT		Y	U	V	EncT	DecT
Class A1	0.00%	0.00%	-0.01%	#NUM!	#NUM!	Class A1					
Class A2	0.01%	-0.01%	-0.04%	#NUM!	#NUM!	Class A2					
Class B	-0.01%	0.01%	0.00%	#NUM!	#NUM!	Class B	0.01%	0.00%	0.00%	#NUM!	#NUM!
Class C	0.02%	0.10%	0.11%	#NUM!	#NUM!	Class C	0.01%	-0.01%	0.02%	#NUM!	#NUM!
Class E				#NUM!	#NUM!	Class E	0.02%	-0.02%	0.05%	#NUM!	#NUM!
Overall	0.00%	0.03%	0.02%	#NUM!	#NUM!	Overall	0.01%	-0.01%	0.02%	#NUM!	#NUM!
Class D	-0.03%	-0.10%	0.02%	#NUM!	#NUM!	Class D	0.00%	0.04%	-0.02%	#NUM!	#NUM!
Class F	0.03%	0.02%	0.07%	#NUM!	#NUM!	Class F	-0.02%	0.06%	0.11%	#NUM!	#NUM!
TGM	0.09%	0.02%	-0.01%	#NUM!	#NUM!	TGM	0.16%	0.19%	0.18%	#NUM!	#NUM!

Simulation results of Q0143, Q0144 and Q0145 (Information)

Lossless

	All Intra			Random Access			Low delay B		
	ratio		bit-rate savings	ratio		bit-rate savings	ratio		bit-rate savings
	VTM7	Q0143+Q0144+Q0145		VTM7	Q0143+Q0144+Q0145		VTM7	Q0143+Q0144+Q0145	
Class A1	2.2	2.4	-4.86%	2.2	2.4	-5.40%			
Class A2	1.6	1.7	-8.39%	1.7	1.8	-7.10%			
Class B	2.2	2.3	-3.96%	2.3	2.4	-2.69%	2.3	2.4	-2.70%
Class C	1.9	2.0	-5.48%	2.4	2.5	-4.50%	2.4	2.5	-4.39%
Class D	1.9	2.0	-5.80%	2.8	2.9	-4.63%	2.7	2.9	-4.55%
Class E	2.8	3.0	-5.95%				3.1	3.4	-6.85%
Class F	5.3	5.5	-3.99%	33.7	34.9	-3.47%	50.7	52.3	-3.34%
TGM	11.8	12.4	-4.19%	107.1	116.4	-6.54%	124.9	136.6	-6.76%
Overall	2.1	2.3	-5.52%	2.2	2.3	-4.60%	2.6	2.7	-4.30%
Enc Time[%]	90%			100%			91%		
Dec Time[%]	101%			100%			103%		

In above test, level mapping only performs on ClassF and ClassTGM.

Conclusion

- **Unified rice parameter derivation in TSRC is proposed**
- **Lossless coding gain is -4.87% AI -3.39% RA -2.29% LB**

→ Propose to adopt our proposal

**Thank Nokia for cross checking!
(JVET-Q0548)**