JVET-Q0243

ADDITIONAL SUPPORT OF DEPENDENT QUANTIZATION WITH 8 STATES

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Adding Support of Dependent Quantization with 8 States

Background

- Coding efficiency of trellis-coded quantization increases with number of quantization states (even though addition gains become smaller and smaller)

Proposal

- Add dependent quantization with 8 states as additional option
- Basically, same decoding process for dep. quant with 4 and 8 states
  - Only state transition table used depends on method chosen
  - Alternatively: Only initial state (per transform block) depends on method chosen
- Straightforward adaptation of VTM-7 high-level signaling

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High-Level Indication of Quantization Method

picture header

…	
if (!pps_dep_quant_enabled_idc)	
~~**pic_dep_quant_enabled_flag**~~	~~u(1)~~
pic_dep_quant_enabled_idc	u(2)
…	

pic_dep_quant_enabled_idc

- 0: conventional quantization
- 1: dep. quantization with 4 states
- 2: dep. quantization with 8 states
- 3: reserved

picture parameter set

…	
if (constant_slice_header_params_enabled_flag)	
pps_dep_quant_enabled_idc	u(2)
…	

pps_dep_quant_enabled_idc

- 0: pic_dep_quant_enabled_idc present in picture headers
- 1: conventional quantization
- 2: dep. quantization with 4 states
- 3: dep. quantization with 8 states

Purely Editorial Modification of Decoding Process in VTM-7

QState	par = 0	par = 1
0	0	2
1	2	0
2	1	3
3	3	1

VTM-7.0 (Working draft & software)

mapping: qidx[k] = (2*absLevel[k] – (Qstate >> 1))

sig_flag ctx: ctxSet[QState] = { 0, 0, 1, 2 }

Rice coding: pos0 = (1 + (Qstate >> 1)) << cRiceParam

QState	par = 0	par = 1
0	0	1
1	2	3
2	1	0
3	3	2

Alternative specification (swap states 1 and 2)

mapping: qidx[k] = (2*absLevel[k] – (Qstate & 1))

sig_flag ctx: ctxSet[QState & 3] = { 0, 1, 0, 2 }

Rice coding: pos0 = (1 + (Qstate & 1)) << cRiceParam

Adding Dependent Quantization with 8 States

QState	par = 0	par = 1
0	0	2
1	5	7
2	1	3
3	6	4
4	2	0
5	4	6
6	3	1
7	7	5

Changes

- Add another state transition table with 8 states
- State transition table depends on selected variant

No other changes in decoding process
(same decoding process for both variants)

mapping: qidx[k] = (2*absLevel[k] – (Qstate & 1))

sig_flag ctx: ctxSet[QState & 3] = { 0, 1, 0, 2 }

Rice coding: pos0 = (1 + (Qstate & 1)) << cRiceParam

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Alternative Implementation (same decoding result)

QState	par = 0	par = 1
0	0	1
1	2	3
2	1	0
3	3	2
4	4	6
5	9	11
6	5	7
7	10	8
8	6	4
9	8	10
10	7	5
11	11	9

Implementation with single state trans. table

- Combined state transition table with 12 states
- Only initial state depends on method chosen

QState = (pic_dep_quant_enabled_idc > 1 ? 4 : 0)

- All other aspects remain the same

Just a different way of describing or implementing the decoding process

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Experimental Results: SDR Common Test Conditions

	All Intra					Random Access					Low Delay B				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
A1	-0.55%	0.02%	0.29%	110%	100%	-0.30%	0.08%	0.38%	102%	99%					
A2	-0.72%	0.01%	-0.05%	112%	99%	-0.41%	0.09%	0.20%	106%	97%					
B	-0.44%	0.16%	0.13%	111%	97%	-0.41%	0.18%	0.40%	107%	99%	-0.53%	-0.13%	0.16%	100%	102%
C	-0.25%	0.03%	0.16%	112%	99%	-0.22%	-0.16%	0.01%	108%	97%	-0.39%	-0.20%	0.04%	109%	96%
E	-0.25%	0.05%	0.16%	112%	100%						-0.21%	1.34%	0.20%	104%	100%
AVG	**-0.43%**	**0.07%**	**0.14%**	**111%**	**99%**	**-0.34%**	**0.05%**	**0.25%**	**106%**	**98%**	**-0.40%**	**0.21%**	**0.13%**	**104%**	**100%**
D	-0.26%	0.07%	-0.02%	116%	97%	-0.20%	0.07%	0.21%	110%	102%	-0.41%	0.01%	-0.55%	108%	101%
F	-0.08%	-0.07%	0.14%	109%	102%	-0.15%	0.01%	0.05%	108%	99%	-0.21%	-0.50%	1.08%	106%	99%

Larger gains (-0.55%, -0.38%, -0.53%) for high-resolution material (classes A1, A2, B)

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Experimental Results: SDR Low QP Test Conditions

	All Intra					Random Access					Low Delay B				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
A1	-0.46%	-0.41%	-0.36%	120%	96%	-0.79%	-0.26%	-0.11%	115%	97%					
A2	-0.46%	-0.52%	-0.54%	124%	97%	-0.70%	-1.51%	-1.29%	117%	97%					
B	-0.44%	-0.33%	-0.35%	122%	97%	-0.74%	-1.72%	-2.98%	114%	97%	-0.73%	-0.15%	-0.09%	117%	96%
C	-0.17%	-0.19%	-0.18%	120%	99%	-0.66%	-0.14%	-0.10%	115%	98%	-0.68%	-0.17%	-0.11%	115%	94%
E	-0.40%	-0.33%	-0.34%	111%	97%						-0.99%	-0.73%	-0.57%	113%	92%
AVG	**-0.38%**	**-0.34%**	**-0.35%**	**120%**	**97%**	**-0.72%**	**-0.96%**	**-1.30%**	**115%**	**97%**	**-0.78%**	**-0.30%**	**-0.22%**	**115%**	**95%**
D	-0.12%	-0.07%	-0.08%	120%	100%	-0.56%	0.15%	0.13%	117%	97%	-0.58%	0.11%	0.00%	114%	92%
F	-0.13%	-0.12%	-0.10%	106%	100%	-0.26%	-0.04%	-0.02%	112%	97%	-0.43%	-0.05%	-0.07%	111%	96%

Experimental Results: HDR Common Test Conditions

	All Intra									
			wPSNR			PSNR				
	DE100	PSNR-L100	Y	U	V	Y	U	V	EncT	DecT
Class H1	-0.01%	-0.30%	-0.34%	0.32%	0.30%	-0.34%	0.33%	0.19%	114%	98%
Class H2						-0.39%	0.18%	0.00%	110%	99%
Overall	-0.01%	-0.30%	-0.34%	0.32%	0.30%	-0.36%	0.28%	0.12%	112%	98%

	Random Access									
			wPSNR			PSNR				
	DE100	PSNR-L100	Y	U	V	Y	U	V	EncT	DecT
Class H1	-0.13%	-0.37%	-0.34%	0.33%	0.16%	-0.33%	0.17%	0.19%	107%	98%
Class H2						-0.39%	0.13%	-0.07%	105%	95%
Overall	-0.13%	-0.37%	-0.34%	0.33%	0.16%	-0.35%	0.15%	0.10%	106%	97%

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Experimental Results: Bin-To-Bit Ratios

CTC	weighted bin-to-bit ratio (1:0.25)						unweighted bin-to-bit ratio					
	Max - Bin2Bit Ratio			Avg - Bin2Bit Ratio			Max - Bin2Bit Ratio			Avg - Bin2Bit Ratio		
	Ref	Test	Diff (%)	Ref	Test	Diff (%)	Ref	Test	Diff (%)	Ref	Test	Diff (%)
AI	1.14	1.15	0.53%	1.14	1.14	0.52%	1.38	1.39	0.43%	1.38	1.39	0.44%
RA	1.13	1.14	0.45%	1.19	1.20	0.70%	1.39	1.40	0.37%	1.42	1.42	0.63%
LB	1.17	1.17	0.76%	1.23	1.24	0.95%	1.41	1.42	0.66%	1.44	1.46	0.92%

LowQP	weighted bin-to-bit ratio (1:0.25)						unweighted bin-to-bit ratio					
	Max - Bin2Bit Ratio			Avg - Bin2Bit Ratio			Max - Bin2Bit Ratio			Avg - Bin2Bit Ratio		
	Ref	Test	Diff (%)	Ref	Test	Diff (%)	Ref	Test	Diff (%)	Ref	Test	Diff (%)
AI	0.93	0.93	-0.05%	0.94	0.94	-0.05%	1.31	1.31	-0.07%	1.31	1.31	-0.07%
RA	0.86	0.86	-0.19%	1.10	1.11	0.40%	1.26	1.26	-0.18%	1.43	1.43	0.32%
LB	0.92	0.92	-0.05%	1.14	1.14	0.50%	1.29	1.29	-0.10%	1.45	1.45	0.42%

Summary

Proposal: Add support of dependent quantization with 8 states

- Gives encoder freedom to achieve additional gains (-0.43%, -0.34%, -0.40% for CTC)
- No burden for decoder implementations
- Straightforward extension of current high-level signaling

Common Test Conditions

- Suggest to keep dependent quantization with 4 states in CTC

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