JCTVC-G154

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De-quantization without Rounding Offset

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Outline

- Summary of the contribution
- Motivation and reasoning
- Results
- Conclusions

Summary of the Contribution

- In HM4.0

```
iShift = QUANT_IQUANT_SHIFT - QUANT_SHIFT - iTransformShift;
iAdd = 1 << (iShift-1);
Int scale = g_invQuantScales[m_cQP.m_iRem] << m_cQP.m_iPer;
for( Int n = 0; n < iWidth*iHeight; n++ ) {
    iCoeffQ = ( piQCoef[n] * scale + iAdd ) >> iShift;
    piCoef[n] = Clip3(-32768,32767,iCoeffQ);
}
```

- Proposed approach

```
if(m_cQP.m_iPer >= iShift)
{
  scale = g_invQuantScales[m_cQP.m_iRem]
  << (m_cQP.m_iPer-iShift);
  for( Int n = 0; n < iWidth*iHeight; n++ ) {
    iCoeffQ =  piQCoef[n] * scale;
    piCoef[n] = Clip3(-32768,32767,iCoeffQ);
  }
}
```

```
else
{
    m_shift = iShift - m_cQP.m_iPer;
    scale = g_invQuantScales[m_cQP.m_iRem];
    for( Int n = 0; n < iWidth*iHeight; n++ ) {
      iCoeffQ =  (piQCoef[n] * scale)>>m_shift;
      piCoef[n] = Clip3(-32768,32767,iCoeffQ);
    }
}
```

Motivation and Reasoning

- Observation:
  - Identical BD rates when "iAdd" is removed under common test condition
- Why ?
  - Two conditions when "iAdd" becomes "useless"

1. m_cQP.m_iPer >= iShift

   (iQP + 6*g_uiBitIncrement)/6 >= g_uiBitIncrement + $\log_2$(TrSize)-1

   iQP/6 >= $\log_2$(TrSize)-1 // Max(TrSize)=32.

   This condition is always met when iQP>=24

2. (piQCoef[n] * scale) % 2^{iShift} = 0

   (piQCoef[n]*g_invQuantScales[ ]%2 $^{(\log_2(TrSize)-1 – iQP/6)}$ = 0

iQP	iQP%6	$\log_2(TrSize)-1 – iQP/6$	$2^{(\log_2(TrSize)-1 – iQP/6)}$	uiQ	(piQCoef[n]*(Int)uiQ) % $2^{(\log_2(TrSize)-1 – iQP/6)}$
iQP >= 24, condition 1 is met.					
iQP < 24, check condition 2					
0	0	4,3,2,1	16, 8, 4, 2	40	?,0,0,0
1	1	4,3,2,1	16, 8, 4, 2	45	?,?,?,?
2	2	4,3,2,1	16, 8, 4, 2	51	?,?,?,?
3	3	4,3,2,1	16, 8, 4, 2	57	?,?,?,?
4	4	4,3,2,1	16, 8, 4, 2	64	0,0,0,0
5	5	4,3,2,1	16, 8, 4, 2	72	?,0,0,0
6	0	3,2,1	8, 4, 2	40	0,0,0
7	1	3,2,1	8, 4, 2	45	?,?,?
8	2	3,2,1	8, 4, 2	51	?,?,?
9	3	3,2,1	8, 4, 2	57	?,?,?
10	4	3,2,1	8, 4, 2	64	0,0,0
11	5	3,2,1	8, 4, 2	72	0,0,0
12	0	2,1	4, 2	40	0,0
13	1	2,1	4, 2	45	?,?
14	2	2,1	4, 2	51	?,?
15	3	2,1	4, 2	57	?,?
16	4	2,1	4, 2	64	0,0
17	5	2,1	4, 2	72	0,0
18	0	1	2	40	0
19	1	1	2	45	?
20	2	1	2	51	?
21	3	1	2	57	?
22	4	1	2	64	0
23	5	1	2	72	0

uiQ= g_invQuantScales[]

Results – Common Test Condition

	All Intra HE			**All Intra LC**		
	Y	U	V	Y	U	V
Class A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class C	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class E	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Overall	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Enc Time[%]		100%			99%	
Dec Time[%]		99%			99%	

	Random Access HE			**Random Access LC**		
	Y	U	V	Y	U	V
Class A	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class C	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class E						
Overall	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Enc Time[%]		100%			100%	
Dec Time[%]		100%			99%	

	Low delay B HE			**Low delay B LC**		
	Y	U	V	Y	U	V
Class A						
Class B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class C	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class E	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Overall	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Enc Time[%]		100%			100%	
Dec Time[%]		100%			100%	

	Low delay P HE			**Low delay P LC**		
	Y	U	V	Y	U	V
Class A						
Class B	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class C	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class E	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Overall	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Enc Time[%]		100%			100%	
Dec Time[%]		100%			100%	

Results – Worst Case

- High bit rate, small QP
- Example 1: “SteamLocomotive” All Intra HE

QP = 9	Bit rate (kbps)	Y PSNR (dB)	U PSNR (dB)	V PSNR (dB)
HM4.0	575965.07	54.13	53.72	53.58
Proposed	580236.65	54.09	53.68	53.54
Difference	+0.7%	-0.04	-0.04	-0.04

- Example 2: “Kimono” All Intra HE

QP = 9	Bit rate (kbps)	Y PSNR (dB)	U PSNR (dB)	V PSNR (dB)
HM4.0	156313.10	53.80	53.75	53.90
Proposed	157262.59	53.80	53.74	53.91
Difference	+0.6%	-0.00	-0.01	+0.01

Conclusion

- It is proposed to remove rounding offset from de-quantization process
  - Save one addition and one shift for each coefficient when (m_cQP.m_iPer >= iShift)
  - Save one addition for each coefficient when (m_cQP.m_iPer < iShift)
  - Identical BD-rates under common test conditions (mathematically proved)
  - May (or may not) have very small impact on bit rate and/or PSNR in very high bit rate (small QP)
- Recommend to adopt the proposed method.

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