

Non-RCE2 and AHG18: Increase in the maximum value of Rice parameter for high bit-depth support

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- Rice parameter for the binarization of *coeff_abs_level_remaining* is updated for each transform coefficient and the maximum value it can reach is 4.
- At the last meeting in Vienna, various methods for update and initialization of Rice parameter were proposed, and RCE2 was established to evaluate them.
- In many approaches, the increase in the maximum value of Rice parameter is proposed as a part of the algorithm.
- Our observation from the test using high bit-depth (12, 14, and 16 bits in AHG18 test of RCE2) shows that **significant coding gain can be achieved for high bit-depth by simply increasing the maximum value of Rice parameter.**
- Based on this observation, in this contribution, **it is proposed to increase the maximum value that Rice parameter can reach in the binarization of *coeff_abs_level_remaining* from 4 to 9.**



- Current Rice parameter update method

```
if(absCoeff[idx] > 3*(1<<uiGoRiceParam))
{
    uiGoRiceParam = min<UInt>(uiGoRiceParam+ 1, 4);
}
```

- Proposed methods – Two options

- Option 1:

```
if(absCoeff[idx] > 3*(1<<uiGoRiceParam))
{
    uiGoRiceParam = min<UInt>(uiGoRiceParam+ 1, 9);
}
```

- Option 2:

```
if(absCoeff[idx] > 3*(1<<uiGoRiceParam))
{
    uiGoRiceParam = min<UInt>(uiGoRiceParam+ 1,
    extended_precision_processing_flag ? 9 : 4);
}
```

Test Results (1/3)



- Anchor: HM12.0-RExt4.1 (AHG8, lossy coding anchor)
- Test condition: RCE2 common test condition (AHG8 configuration)
- The proposed increase in the maximum value of Rice parameter has almost no impact on lossy coding in AHG8 test configuration.

BD-rate Y	AI-MT	AI-HT	AI-SHT	RA-MT	RA-HT	LB-MT	LB-HT
Class F	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Class B	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC RGB 444	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
Animation RGB	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC YUV 444	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Animation YUV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RangeExt	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SC(444) GBR	0.0%	0.0%	-0.1%	0.0%	0.0%	0.1%	-0.3%
SC(444) YUV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
Enc Time[%]	101%	101%	101%	100%	100%	100%	100%
Dec Time[%]	101%	101%	101%	100%	100%	100%	100%



- Anchor: HM12.0-RExt4.1 (AHG8, lossless coding anchor)
- Test condition: RCE2 common test condition (AHG8 configuration)
- The proposed increase in the maximum value of Rice parameter provides the coding gain for both SC (e.g. 0.1% for SC YUV 444 in AI) and natural video sequences (e.g. 0.4% for RangeExt in AI).

Bit-rate saving (Average)	AI-Main	RA-Main	LB-Main
Class F	0.1%	0.1%	0.0%
Class B	0.0%	0.0%	0.0%
SC RGB 444	0.4%	0.2%	0.2%
Animation RGB	0.0%	0.0%	0.0%
SC YUV 444	0.1%	0.1%	0.1%
Animation YUV	0.0%	0.0%	0.0%
RangeExt	0.4%	0.2%	0.1%
SC(444) GBR	0.5%	0.4%	0.1%
SC(444) YUV	0.2%	0.1%	0.2%
Enc Time[%]	100%	100%	100%
Dec Time[%]	101%	100%	100%



- Anchor: HM12.0-RExt4.1 (AHG18 anchor)
- Test condition: RCE2 common test condition (AHG18 configuration)
- The proposed increase in the maximum value of Rice parameter can provide the significant coding gain for high bit-depth for both "HPT disabled" and "HPT enabled" tests.

HPT disabled

Internal Bit-depth	All Intra		
	Y	U	V
12-bit	-1.9%	-2.0%	-2.0%
14-bit	-8.4%	-8.3%	-8.3%
16-bit	-14.1%	-14.0%	-14.1%
Enc Time[%]	97%		
Dec Time[%]	96%		

HPT enabled

Internal Bit-depth	All Intra		
	Y	U	V
12-bit	-2.1%	-2.0%	-2.0%
14-bit	-8.8%	-8.5%	-8.5%
16-bit	-14.5%	-14.2%	-14.2%
Enc Time[%]	97%		
Dec Time[%]	96%		



- In this contribution, it is proposed to increase the maximum value of Rice parameter from 4 to 9 for high bit-depth support in the binarization process of *coeff_abs_level_remaining*.
- The test results under AHG18 test condition show that this simple change provides the significant coding gain for high bit-depth sequences.
- It is suggested to adopt this method into the next version of HEVC Range Extension text and reference software, and evaluate the other Rice parameter update and initialization methods on top of this simple yet effective method.

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THANK YOU



- Anchor: HM12.0-RExt4.1 (AHG18 anchor, HPT disabled)
- Test condition: RCE2 common test condition (AHG18 configuration)
- The coding gain improvement for each maximum value of Rice parameter (5~16) shows that **the maximum value of 9 is a reasonable choice.**

