

BoG report on efficient binary representation of cu_qp_delta syntax for CABAC (JCTVC-F046 and JCTVC-F422)

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HM3.0 binarization

- # of bins of a bin string is proportional to $2 * |dQP|$
- **Unary binary representation** allows encoders to send prohibited values
 - Due to the cyclic reconstruction, for example, if $QP_{prev}=0$, then $dQP=-25$ and prohibited $dQP=27$ yield identical QP.

cu_qp_delta	Bin string													
	1st	2nd	3rd	4th	5th	6th	7th	...	49th	50th	51st	52nd	53rd	54rd
0	0													
1	1	0												
-1	1	1	0											
2	1	1	1	0										
...														
-25	1	1	1	1	1	1	1	...	1	1	0			
26	1	1	1	1	1	1	1	...	1	1	1	0		
-26	1	1	1	1	1	1	1	...	1	1	1	1	0	
27	1	1	1	1	1	1	1	...	1	1	1	1	1	0
Context index	0	2	3	3	3	3	3		3	3	3	3	3	3

JCTVC-F422 binarization

- Signal $|cu_qp_delta|$ by using unary binarization
 - Signal significance of cu_qp_delta in the first bin;
 - Signal $|cu_qp_delta - 1|$ by using an unary binarization;
 - Signal its sign separately.

$ cu_qp_delta $	Bin string									
	1st	2nd	3rd	4th	5th	6th	...	26th	27th	Sign
0	0									na
1	1	0								X
2	1	1	0							X
3	1	1	1	0						X
4	1	1	1	1	0					X
5	1	1	1	1	1	0				X
...										
25	1	1	1	1	1	1	...	0		X
26	1	1	1	1	1	1	...	1	0	X
Context index	0	2	3	3	3	3	...	3	3	na

JCTVC-F046 binarization

- Signal $|\text{cu_qp_delta}|$ by using truncated unary binarization
 - Signal significance of cu_qp_delta in the first bin;
 - Signal its sign in the second bin and determine cMax by;

$$\text{cMax} = 24 + (\text{QpBdOffsetY}/2) + (\text{cu_qp_delta} < 0? 1 : 0)$$
 - Signal $|\text{cu_qp_delta} - 1|$ by using truncated unary binarization with cMax .

$ \text{cu_qp_delta} $	Bin string									
	1st	2nd	3rd	4th	5th	6th	...	26th	27th	28th
0	0									
1	1	X	0							
2	1	X	1	0						
3	1	X	1	1	0					
4	1	X	1	1	1	0				
5	1	X	1	1	1	1				
...										
25	1	X	1	1	1	1	...	1		
26	1	X	1	1	1	1	...	1	1	
Context index	0	na	2	3	3	3	...	3	3	3

Save more than 2.57 bit

Save more than 2.64 bit

Truncated unary binary representation assures that encoders never send prohibited values.

Analysis

- For both JCTVC-F046 and JCTVC-F422, # of bins of bin string is proportional to $|dQP|$
 - Roughly halve both maximum and average of bin string length;
 - Significant complexity reduction
- In addition, JCTVC-F046 (truncated unary binarization) assures that encoders do not send prohibited values
 - Decoders are released from checking of semantics error
- Coding efficiency and complexity of JCTVC-F046 and JCTVC-F422 are very comparable
 - WD text and software changes are very minor.

Recommendation

- Signaling significance bin, sign bin, and $|cu_qp_delta - 1|$ with truncated binarization is adopted into HM4.0

$ cu_qp_delta $	Bin string									
	1st	2nd	3rd	4th	5th	6th	...	26th	27th	28th
0	0									
1	1	X	0							
2	1	X	1	0						
3	1	X	1	1	0					
4	1	X	1	1	1	0				
5	1	X	1	1	1	1				
...										
25	1	X	1	1	1	1	...	1		
26	1	X	1	1	1	1	...	1	1	
Context index	0	na	2	3	3	3	...	3	3	3

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