

JVET-00428: AHG16/AHG17: LMCS related clean-ups

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Summary of Proposal

- Three aspects of LMCS related clean-ups in VVC specification and VTM software
 - Aspect 1: Bug fix in the process of identifying the index of inverse piecewise function
 - Aspect 2: LMCS code improvements
 - Aspect 3: Constraints on LMCS APS

Aspect 1: Bug fix in finding the index of inverse piecewise function

- A bug is identified in both spec and software regarding finding idx of inverse PWL
- Fix: Replace "<" with "<=" in the piece finding loop (also cleanup redundant if and elseif check)
- Description of bug
 - Samples outside the valid range are created due to lossy compression
 - Without bug fix, the wrong PWL index value can be returned for such samples
 - With the proposed fix, the correct PWL index value is returned for such samples

Example:

- LMCS model with 14 pieces
- min piece index 1 and max piece index 14
- LmcsPivot[14] = 815 and LmcsPivot[15] = 879.
- Sample values between [815 879) should return piece index 14
- Sample values ≥ 879 should return index 15 (with fix) instead of 14 (without fix)

Aspect 1: Specification Change

- In clause 8.8.2.3, modify equation 8-1003:

```
if ( lumaSample < LmcsPivot[ lmcs_min_bin_idx + 1 ] )  
    idxYInv = lmcs_min_bin_idx  
else if ( lumaSample > LmcsPivot[ LmcsMaxBinIdx ] )  
    idxYInv = LmcsMaxBinIdx  
else {  
    for( idxYInv = lmcs_min_bin_idx; idxYInv <= LmcsMaxBinIdx; idxYInv++ ) {  
        if( lumaSample < LmcsPivot [ idxYInv + 1 ] )  
            break  
    }  
}
```

(8-1003)

Aspect 1: Results

Bugfix over VTM5.0 SDR CTC

	All Intra Main10			Random access Main10			Low delay B Main10		
	Y	U	V	Y	U	V	Y	U	V
Class A1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%			
Class A2	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%	0.00%	0.01%	0.01%
Class C	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	-0.03%	-0.01%
Class E	0.00%	0.00%	0.00%	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%	-0.01%	0.00%
Class D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Class F	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	-0.05%

- No essential change in BD-rate and Enc/Dec time

Aspect 2: LMCS code clean-up for readability and correspondence

- Software-only clean up on LMCS, aiming at:
 - make the code cleaner, more readable, more compact (reduce # of lines)
 - have exact correspondence to the specification
- Changes to the current VTM software are:
 - Align the variable names in the code same as what is in specification: `InvScaleCoeff[]`, `ScaleCoeff[]`, `InputPivot[]` and `ChromaScaleCoeff[]`.
 - Remove unnecessary functions such as `reverseLUT()` and `updateChromaScaleLUT()`;
- No change on coding performance
- No specification change regarding this aspect

Aspect 3: Constraints on LMCS APS

- The current VVC draft specification text is incomplete about parameter set storage and activation.
- To ease implementation and constrain worst-case memory requirements, it is proposed to add the following constraints on LMCS APS:
 - The total number of LMCS APS shall be less than or equal to 4.
 - Only one LMCS model per picture shall be allowed.

Aspect 3 Specification Change

- In clause 7.4.6.1, the semantics of **slice_lmcs_aps_id** is changed as follows:

slice_lmcs_aps_id specifies the adaptation_parameter_set_id of the LMCS APS that the slice refers to. The value of slice_lmcs_aps_id shall be in the range of 0 to 3, inclusive. The TemporalId of the LMCS APS NAL unit having adaptation_parameter_set_id equal to slice_lmcs_aps_id shall be less than or equal to the TemporalId of the coded slice NAL unit.

~~When multiple LMCS APSs with the same value of adaptation_parameter_set_id are referred to by two or more slices of the same picture, the multiple LMCS APSs with the same value of adaptation_parameter_set_id shall have the same content.~~

Only one LMCS APS with the same value of adaptation_parameter_set_id and the same content shall be referred to by one or more slices of the same picture.

Conclusion

- Three aspects of specification and software clean ups related to LMCS are proposed
 - Bugfix
 - Code cleanup
 - APS constraints
- Recommended for adoption into the VVC draft specification and VTM software

Acknowledgement

- We would like to thank Alibaba for crosschecking the test results.

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