



AHG-4: Non-cross-tiles Loop Filtering for Independent Tiles

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Overall Summary

- In current HM, loop filtering operations are allowed to cross tile boundaries for independent tiles
 - Decrease the parallel processing capability of independent tiles
- In this contribution,
 - Non-cross-tiles loop filtering operations are proposed
 - 1-bit flag is proposed in PPS to control cross-tile/non-cross-tiles loop filtering operations
- Average 0.1% BD-rate increase for 2-tile and 4-tile cases

Problem Definition

- Independent tiles (JCTVC-F335, Tiles)
 - Tile boundaries break prediction mechanisms
 - **tile_boundary_independent_idc** = 1
- Problem
 - Loop filters are still allowed to cross tile boundaries when **tile_boundary_independent_idc** is equal to 1
 - Decrease the parallel processing capability for independent tiles

Proposed Methods

- Non-cross-tiles boundary loop filtering operations are proposed
- 1-bit flag is proposed in PPS to control loop filtering behavior on tile boundaries

Non-cross-tiles Loop Filtering

- The same as non-cross-slice processing in HM-4.0
- Deblocking filter
 - Bypass pixels at tile boundaries
- Sample adaptive offset (SAO)
 - Skip edge offset (EO) if filtering one pixel may use other pixel at different tiles
- Adaptive loop filter (ALF)
 - Padding is used
 - Vertical edges first and then horizontal edges

1-bit Flag to Control Loop Filter Behavior

- Only coded when the following two conditions are satisfied
 - Number of tiles in picture is larger than one
 - Independent tiles are used

pic_parameter_set_rbsp() {	Descriptor
...	
if(num_tile_columns_minus1 != 0 num_tile_rows_minus1 != 0) {	
if(tile_boundary_independent_idc == 1) {	
loop_filter_across_tile_flag	u(1)
}	
}	
rbsp_trailing_bits()	
}	

Simulation Results: 2 Tiles

- Anchor
 - HM-4.0-dev (rev. 1420)
 - 2 uniformly spaced vertical tiles
 - Independent tiles are enabled
- Results
 - Maximum 0.1% BD-rate increase in luma
 - Maximum 0.2% BD-rate increase in chroma

	HE-AI	HE-RA	HE-LD	LC-AI	LC-RA	LC-LD
Y	0%	0.1%	0%	0%	0%	0%
U	0.1%	0.1%	0.2%	0.1%	0.1%	0%
V	0.1%	0.2%	0.2%	0.1%	0%	0%

Simulation Results: 4 Tiles

- Anchor
 - HM-4.0-dev (rev. 1420)
 - 4 uniformly spaced vertical tiles
 - Independent tiles are enabled
- Results
 - Maximum 0.1% BD-rate increase in luma.
 - Maximum 0.4% BD-rate increase in chroma

	HE-AI	HE-RA	HE-LD	LC-AI	LC-RA	LC-LD
Y	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
U	0.4%	0.2%	0.3%	0.3%	0.1%	0.1%
V	0.4%	0.2%	-0.1%	0.3%	0.1%	0.3%

Crosscheck Verifications

- We thank eBrisk for crosschecking our proposal
 - JCTVC-G802
- The BD-rate results of 2-tile case are confirmed
- Software is verified

Conclusions

- Non-cross-tiles loop filtering was proposed for independent tiles
- 1-bit flag in PPS was proposed to control tile boundary behavior for loop filtering
- Enable fully parallel tile processing with minor BD-rate impact of non-cross-tiles loop filtering
- Recommend to adopt the 1-bit flag in PPS to control loop filtering behavior on tile boundaries when independent tiles are enabled