

# **F494 -- Complexity reduction of chroma intra LM prediction mode**

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# Background

## ❖ Using sum instead of average for Luma downsampling

### (1) Luma downsample

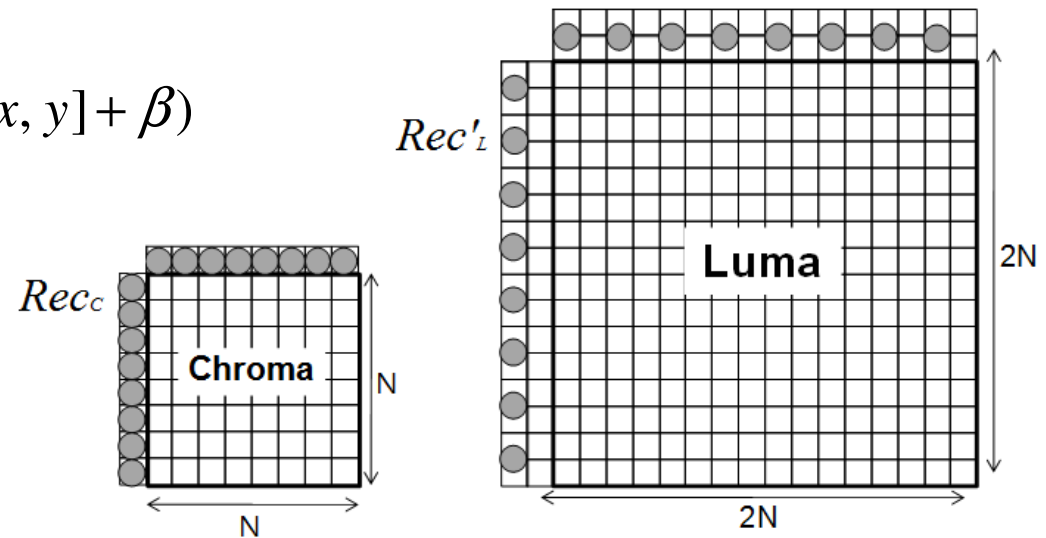
$$Rec_L'[x, y] = (Rec_L[2x, 2y] + Rec_L[2x, 2y + 1]) \gg 1$$

### (2) Calculate alpha and beta with neighboring pixels

$$\alpha = \frac{I \cdot \sum_{i=0}^I Rec_C(i) \cdot Rec_L'(i) - \sum_{i=0}^I Rec_C(i) \cdot \sum_{i=0}^I Rec_L'(i)}{I \cdot \sum_{i=0}^I Rec_L'(i) \cdot Rec_L'(i) - \left( \sum_{i=0}^I Rec_L'(i) \right)^2} = \frac{A_1}{A_2} \quad \beta = \frac{\sum_{i=0}^I Rec_C(i) - \alpha \cdot \sum_{i=0}^I Rec_L'(i)}{I}$$

### (3) Get prediction

$$pred_C[x, y] = clip(\alpha \cdot rec'[x, y] + \beta)$$



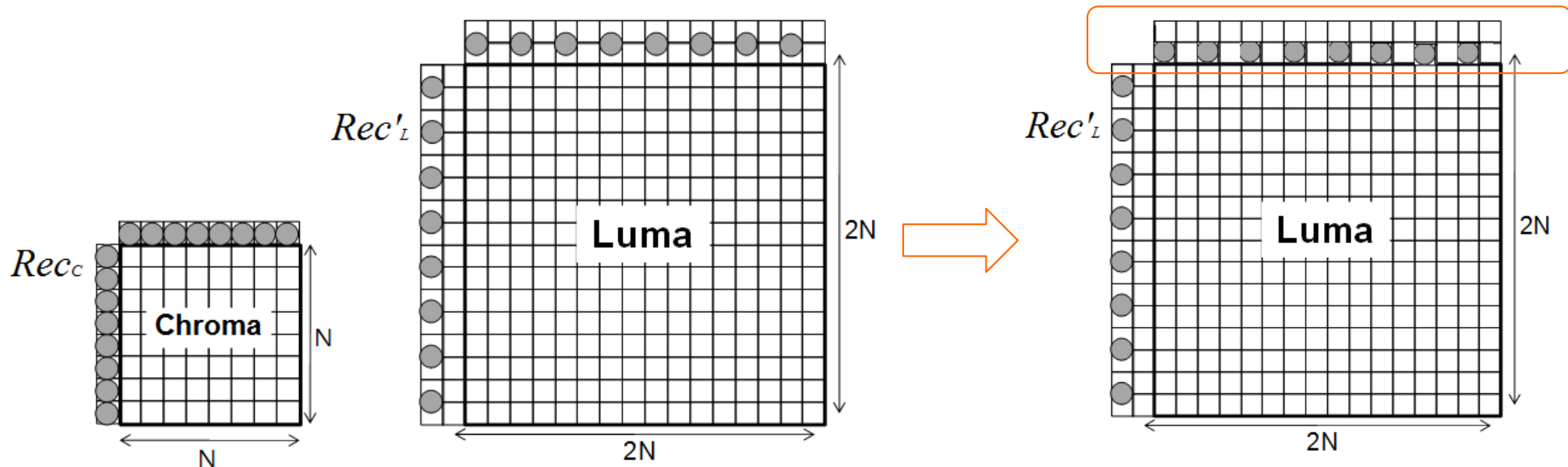
# One line buffer for luma signal

## ❖ Modification

- Use the first reference line of the above side to calculate LM parameter alpha and beta

## ❖ Motivation

- Reduce luma reference line buffer (2 lines -> 1 line)
- Alignment of reference pixel access of LM mode and other intra mode



# Results of one line buffer

## ❖ Results (Y/Cb/Cr)

- HE\_AI : 0.0%/0.4%/0.3%
- LC\_AI : 0.0%/0.4%/0.3%

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	1.1	0.5	0.0	1.2	0.6
Class B	0.0	0.3	0.2	0.0	0.2	0.1
Class C	0.1	0.4	0.5	0.1	0.4	0.4
Class D	0.0	0.2	0.2	0.0	0.2	0.1
Class E	0.0	0.0	0.1	0.0	0.1	0.1
<b>Overall</b>	<b>0.0</b>	<b>0.4</b>	<b>0.3</b>	<b>0.0</b>	<b>0.4</b>	<b>0.3</b>
Enc Time[%]	99%			99%		
Dec Time[%]	99%			99%		

# Remove shift operation

❖ Use “sum” instead of “Average” for luma downsampole

- Remove shift operation

$$Rec_L'[x, y] = (Rec_L[2x, 2y] + Rec_L[2x, 2y + 1]) \gg 1$$

- Results

- HE\_AI : 0.0%, -0.3%, -0.4%,
- LC\_AI : 0.0%, 0.0%, 0.0%,

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	-1.6	-1.9	0.0	-0.1	-0.1
Class B	0.0	0.0	0.1	0.0	0.0	0.0
Class C	0.0	0.0	0.0	0.0	0.0	0.0
Class D	0.0	0.0	0.0	0.0	0.0	0.0
Class E	0.0	-0.1	0.1	0.0	0.0	0.0
<b>Overall</b>	<b>0.0</b>	<b>-0.3</b>	<b>-0.4</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
Enc Time[%]	100%			100%		
Dec Time[%]	100%			99%		

# Skip clip operation

- ❖ Skip Clip operation of final prediction value

$$pred_c[x, y] = clip(\alpha \cdot rec'[x, y] + \beta)$$

- ❖ Results

- No performance change

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	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
Class C	0.0	0.0	0.0	0.0	0.0	0.0
Class D	0.0	0.0	0.0	0.0	0.0	0.0
Class E	0.0	0.0	0.0	0.0	0.0	0.0
<b>Overall</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>
Enc Time[%]	100%			100%		
Dec Time[%]	100%			99%		

# Bug fix

## ❖ Bug fix

- Index to access the table is shifted by one in HM3.1 software
- "+1" should be removed

$$a2s = ( a2 \gg \text{Max}(0, \log_2( \text{abs}( a2 ) ) - 5 )) + 1$$

## ■ Results

- HE\_AI : 0.0%, -0.1%, -0.1%
- LC\_AI : 0.0%, -0.1%, -0.1%

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	-0.3	-0.3	0.0	-0.4	-0.3
Class B	0.0	-0.1	-0.1	0.0	-0.1	0.0
Class C	0.0	-0.1	-0.1	0.0	-0.1	-0.2
Class D	0.0	-0.1	0.0	0.0	0.0	0.0
Class E	0.0	-0.1	0.0	0.0	0.0	0.0
<b>Overall</b>	<b>0.0</b>	<b>-0.1</b>	<b>-0.1</b>	<b>0.0</b>	<b>-0.1</b>	<b>-0.1</b>
Enc Time[%]	100%			100%		
Dec Time[%]	100%			99%		

# Whole package

## ❖ Contents

- One luma signal line buffer
- Remove shift operation for luma dowsampling
- Skip clip operation of final prediction value
- Bugfix

	All Intra HE			All Intra LC		
	Y	U	V	Y	U	V
Class A	0.0	-0.7	-1.3	0.0	0.8	0.4
Class B	0.0	0.2	0.2	0.0	0.2	0.1
Class C	0.1	0.3	0.3	0.1	0.2	0.3
Class D	0.0	0.1	0.1	0.0	0.1	0.1
Class E	0.0	-0.1	0.2	0.0	0.1	0.1
<b>Overall</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.1</b>	<b>0.0</b>	<b>0.3</b>	<b>0.2</b>
Enc Time[%]	99%			98%		
Dec Time[%]	99%			98%		



# Summary

## ❖ Modification

- BugFix for table access for replacing division operation
- Using the first top neighboring luma line buffer for parameter calculation
  - Reduce line buffer from 2 -> 1
  - Alignment neighboring access method with other intra mode
- Remove shift operation for luma downsampling
- Skip clip operation of final prediction value

## ❖ Coding performance

- HE\_AI: 0.0%/0.0%/-0.1%
- LC\_AI : 0.0%/0.3%/0.2%

- ❖ we propose to adopt proposed modification to reduce the complexity of chroma prediction by luma mode.



Thank you !