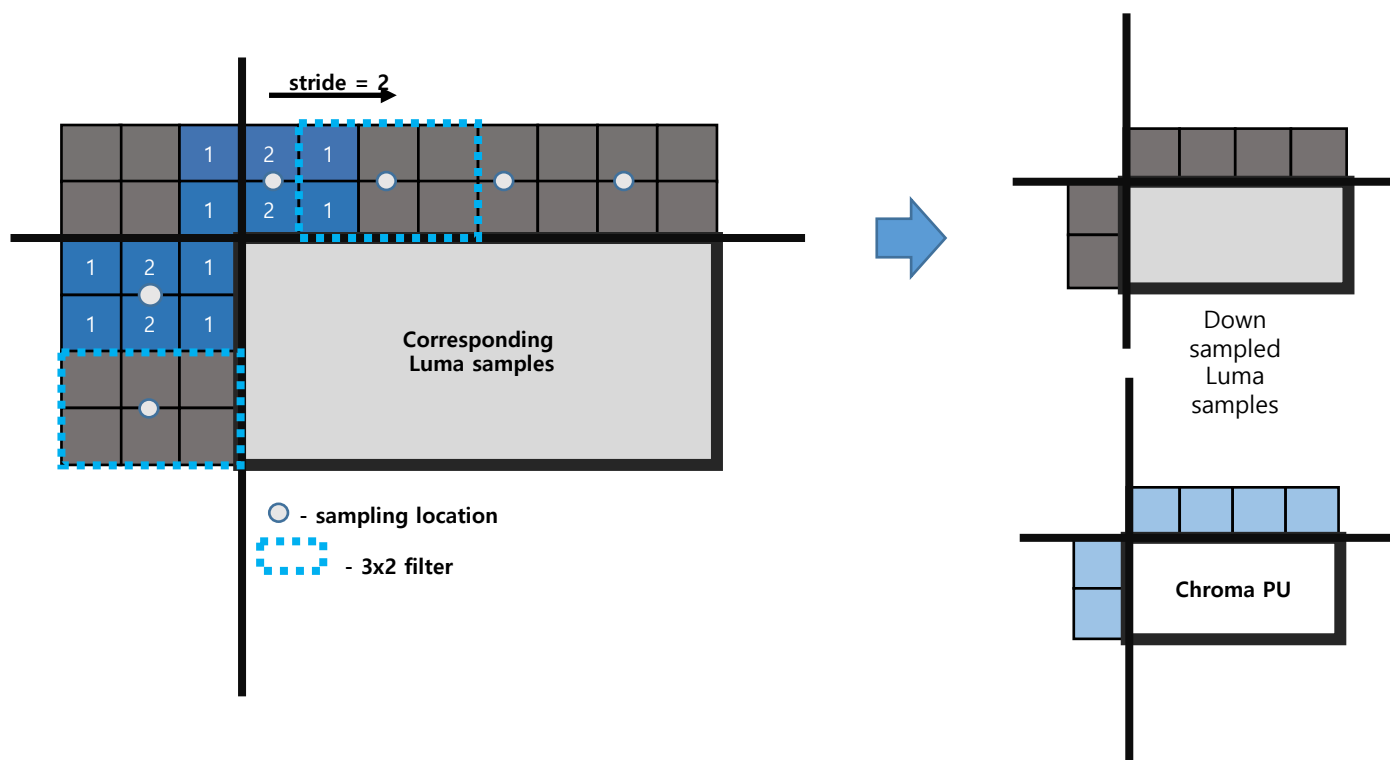


[JVET-L0065]
CE3-related:
**One-line CCLM for reduction
of reference sample lines**

Kwangwoon University (KWU)

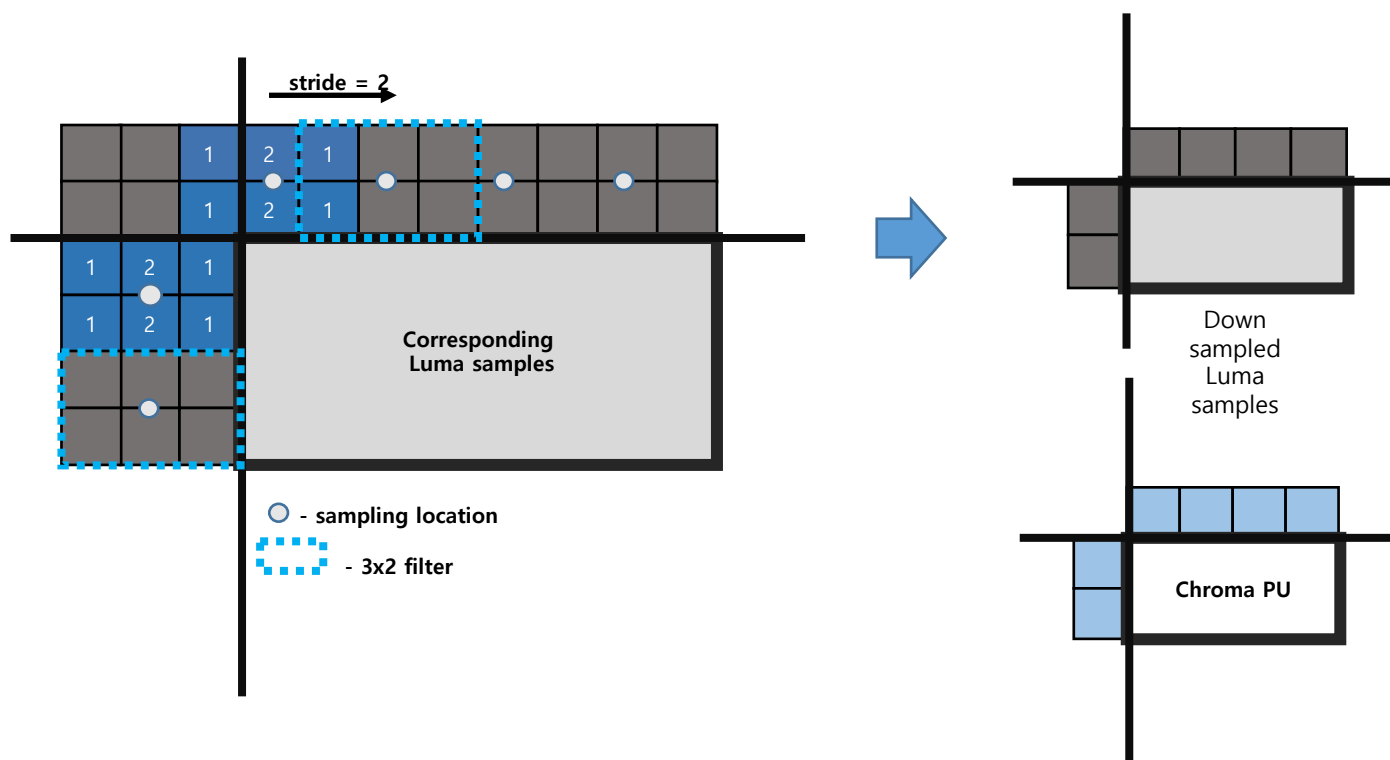
Introduction

- In VTM-2.0.1
 - Down-sampling process is required to match the resolution to Luma and Chroma in 4:2:0 sub sampling condition for the CCLM mode



Introduction

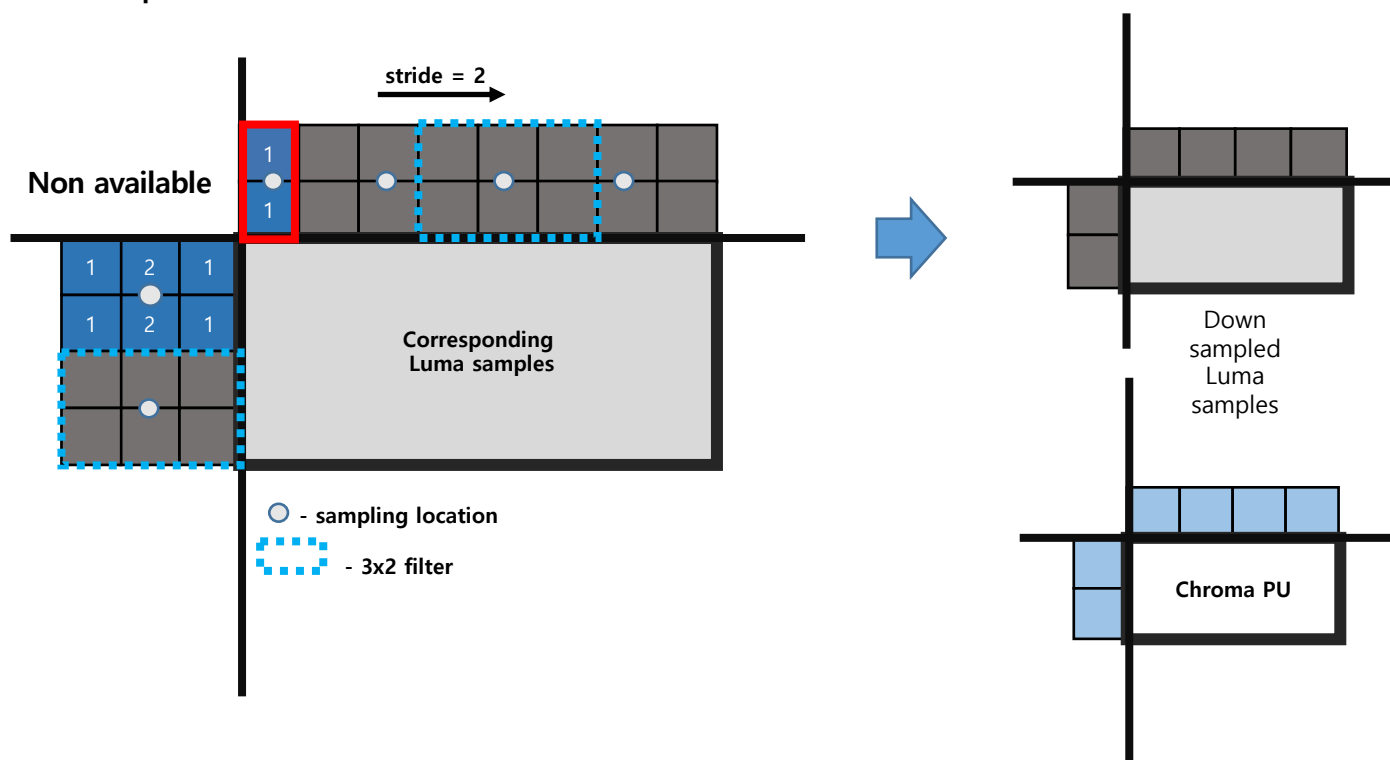
- In VTM-2.0.1
 - Down-sampling process uses the 3x2 filter with stride as 2



Introduction

■ In VTM-2.0.1

- Down-sampling process uses the 3x2 filter with stride as 2
- If the top-left samples are non-available, 1x2 filter is employed at the top-left of the current CU

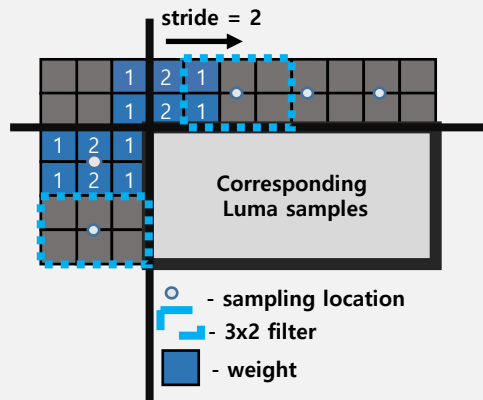


Introduction

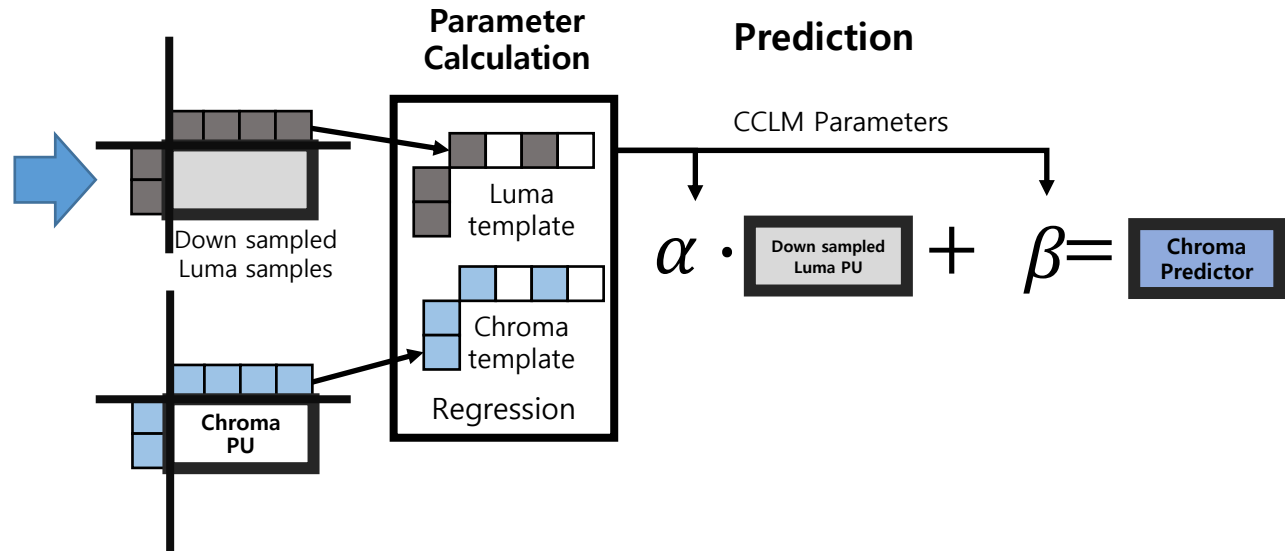
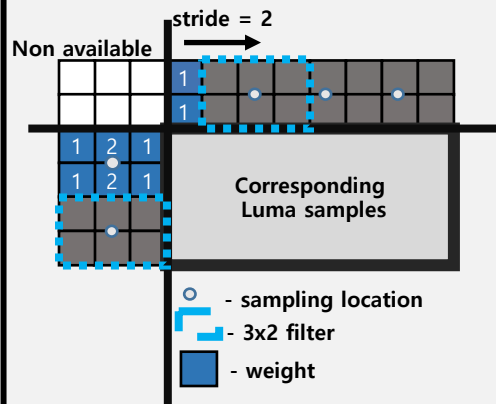
- Diagram of the CCLM in VTM-2.0.1

Down-sampling for luma

General Case

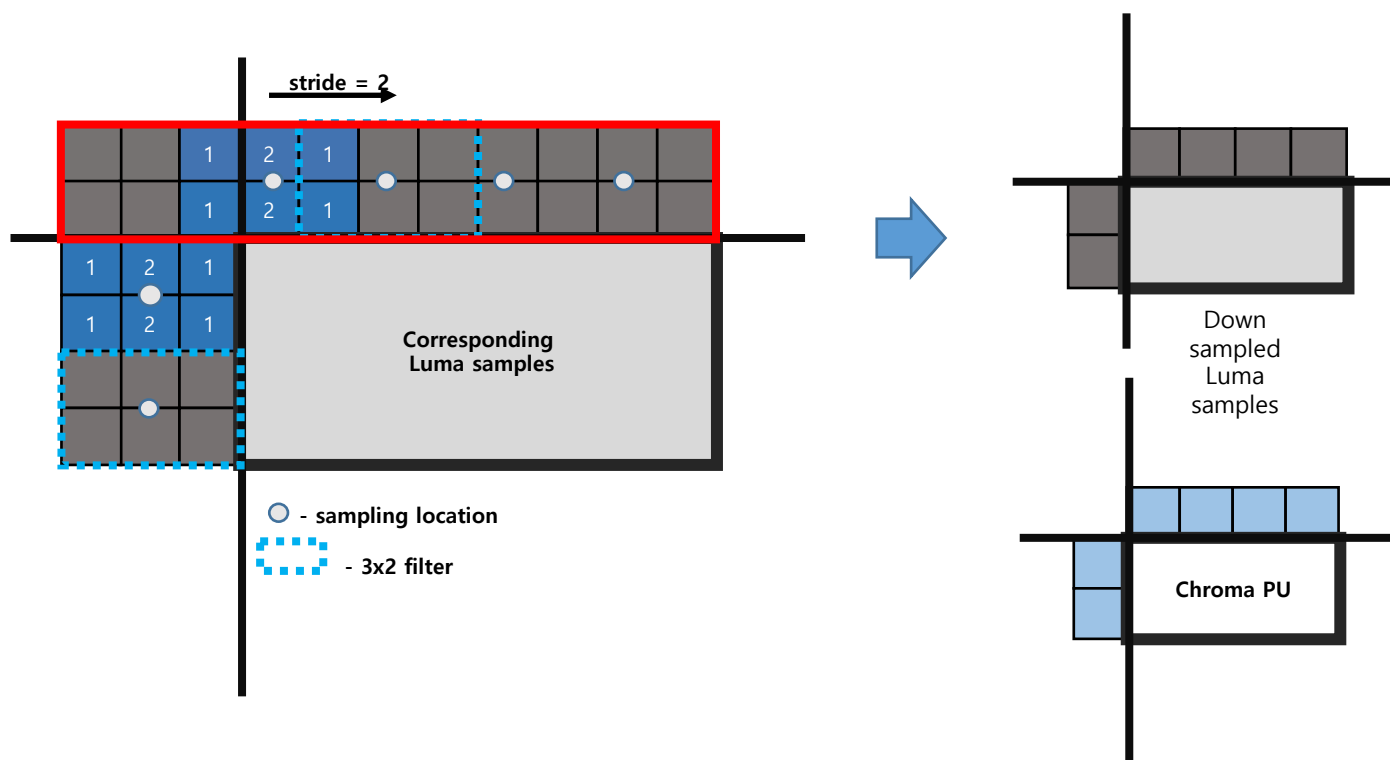


non-available Top-Left PU



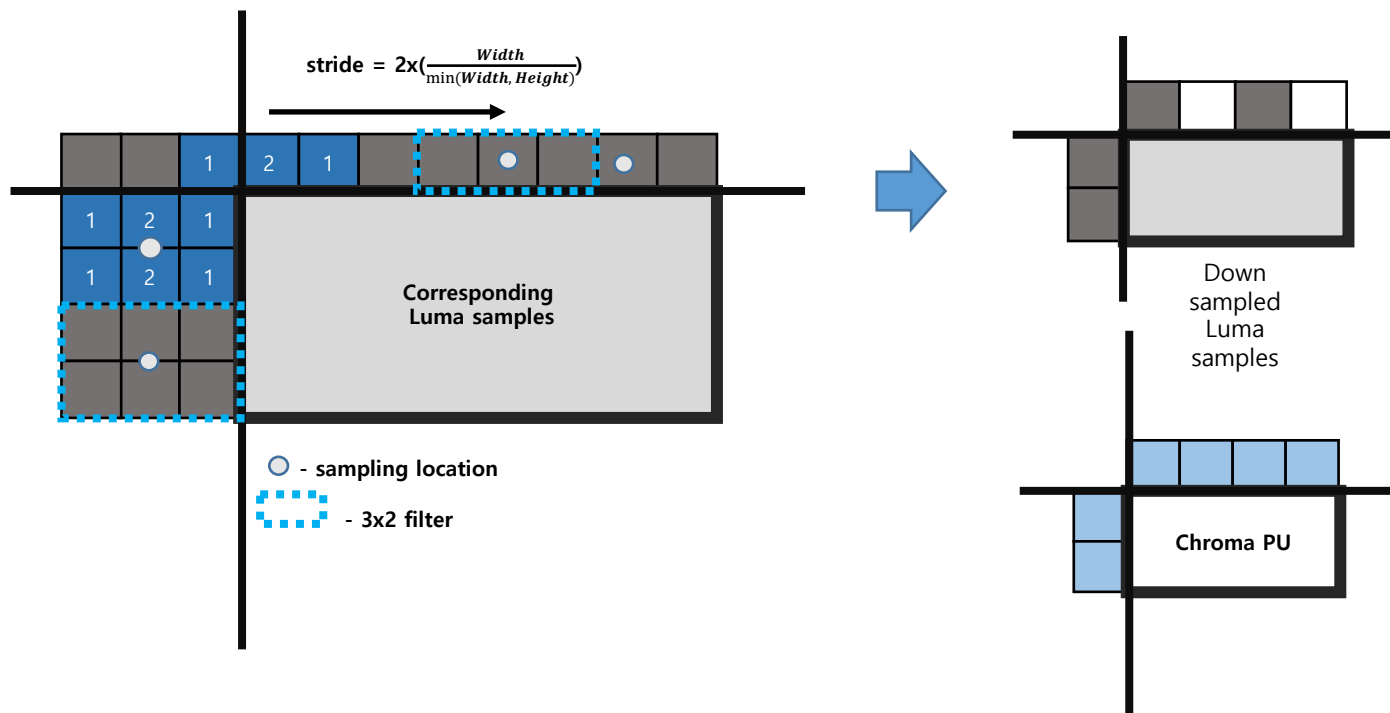
Proposed Method

- In VTM-2.0.1
 - The CCLM mode requires two line buffer for Luma



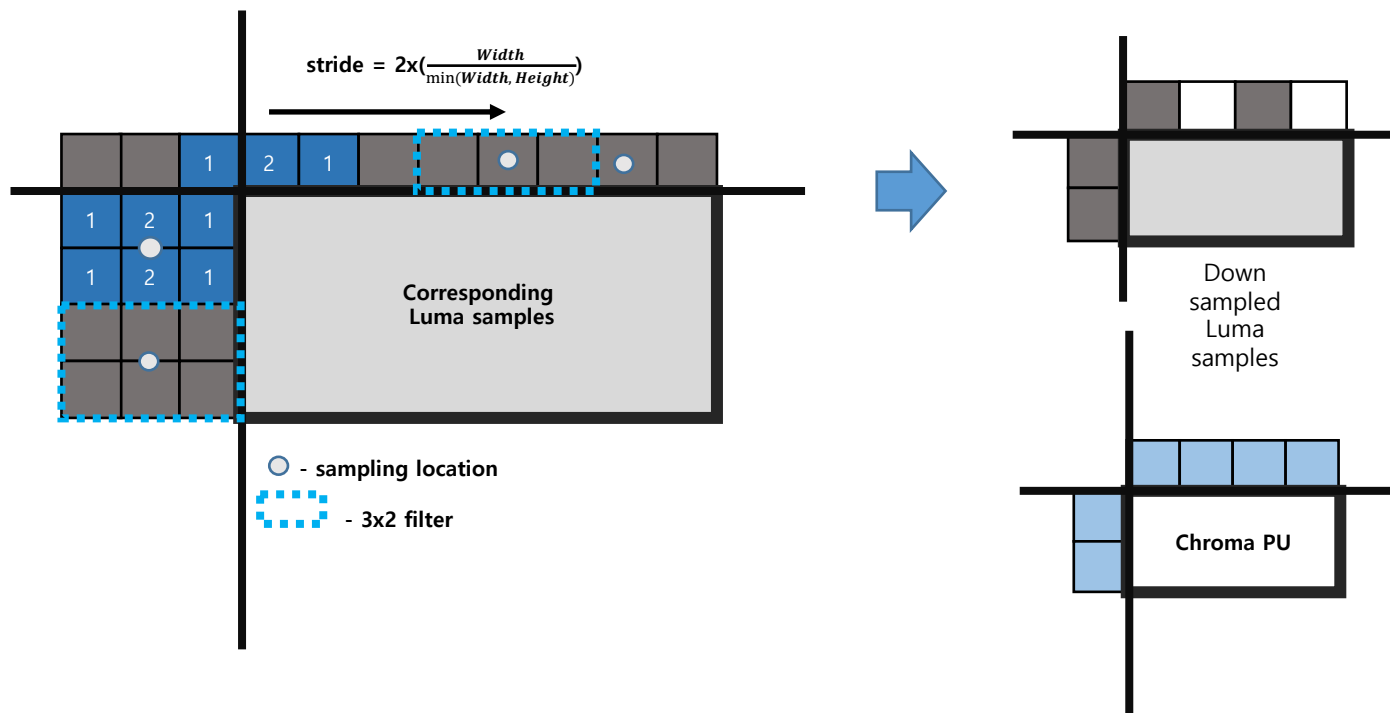
Proposed Method

- In the proposed method
 - One reconstructed Luma sample line of the upper side of the corresponding Luma block is employed



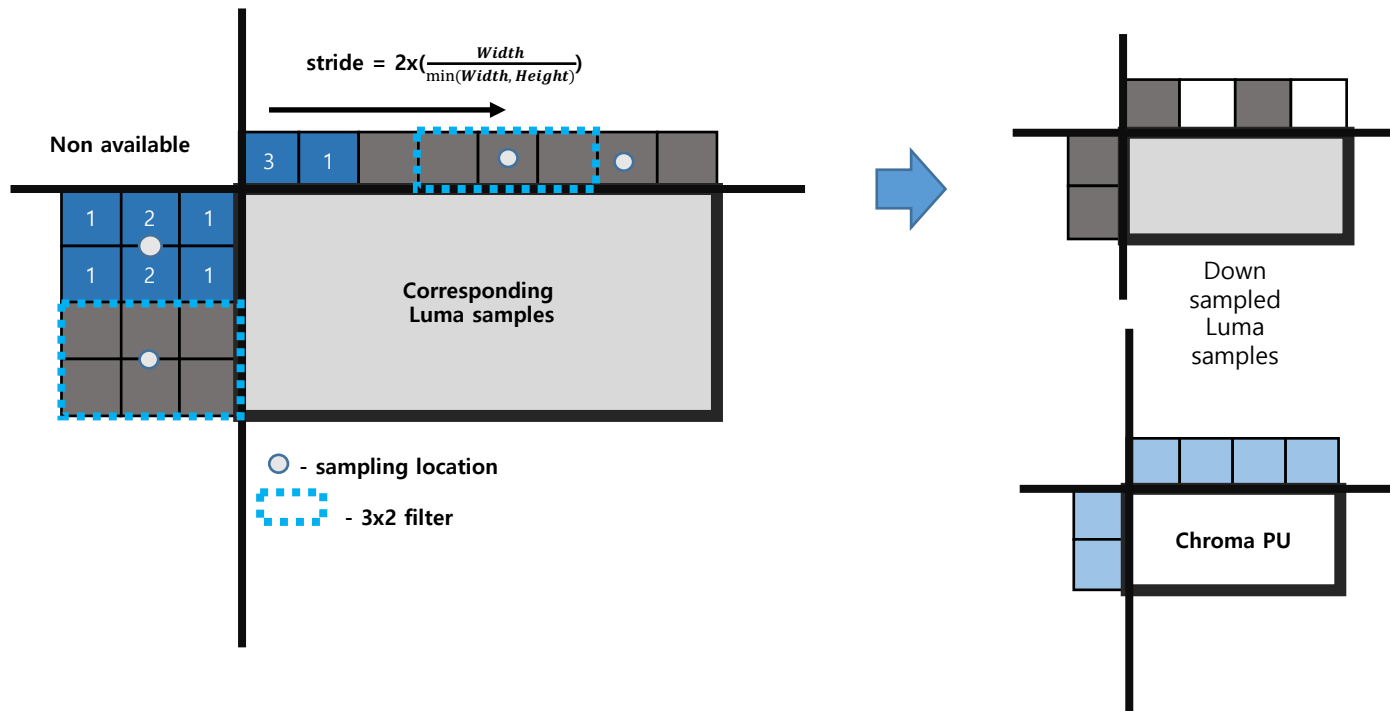
Proposed Method

- In the proposed method
 - The 3x1 filter is employed with a stride as $\frac{2Width}{\min(Width, Height)}$



Proposed Method

- In proposed method
 - The 3x1 filter is employed with a stride as $\frac{2Width}{\min(Width, Height)}$
 - If the top-left samples are not available, the 2x1 filter is employed

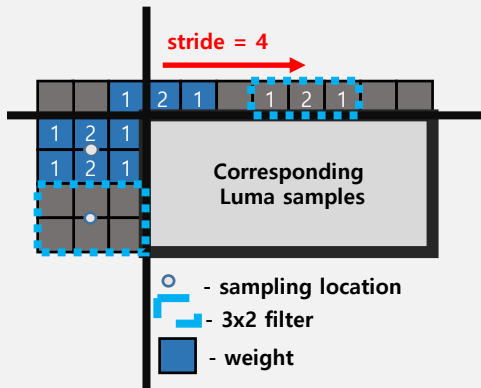


Proposed CCLM Mode

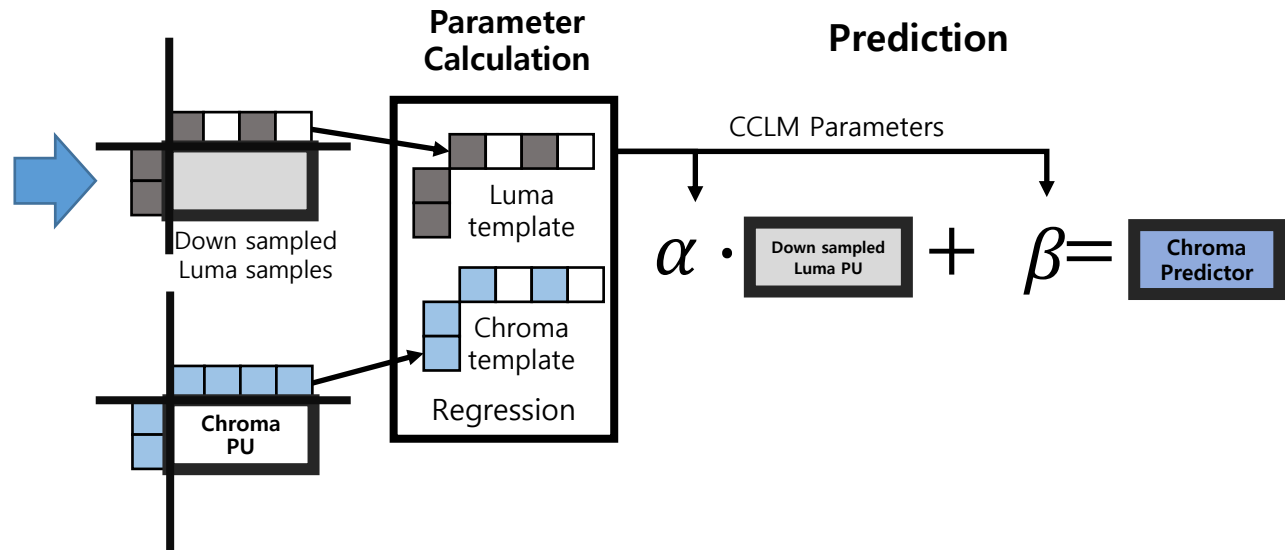
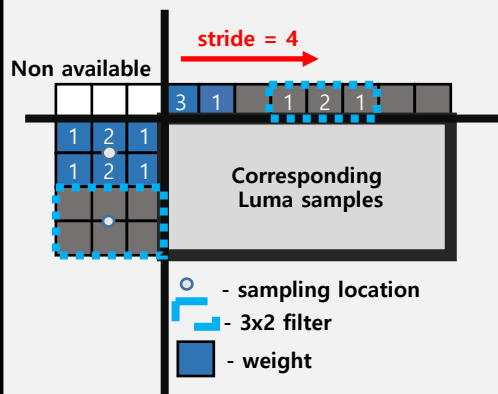
- Diagram of the proposed CCLM method

Down-sampling for Luma

General Case



non-available TopLeft PU



Comparison of RD performance

- Table 1. RD performance of VTM-2.0.1 without CCLM

All Intra Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	5.93%	42.77%	32.62%	100%	102%
Class A2	2.20%	15.19%	7.72%	96%	99%
Class B	1.10%	10.89%	15.71%	98%	100%
Class C	1.92%	14.40%	15.80%	99%	100%
Class E	0.40%	5.18%	5.32%	100%	97%
Overall	2.15%	16.75%	15.49%	99%	100%
Class D	1.23%	11.14%	10.76%	100%	99%

- Table 2. RD performance of one-line CCLM on the top of VTM-2.0.1

All Intra Main10					
Over VTM-2.0.1					
	Y	U	V	EncT	DecT
Class A1	0.03%	0.60%	0.36%	98%	100%
Class A2	0.03%	0.16%	0.06%	96%	100%
Class B	0.02%	0.12%	0.29%	101%	100%
Class C	0.03%	0.28%	0.32%	100%	100%
Class E	-0.01%	0.05%	-0.02%	100%	97%
Overall	0.02%	0.23%	0.22%	99%	100%
Class D	0.02%	0.26%	-0.02%	101%	93%

Conclusion

- This contribution presents a modified Cross Component Linear Model (CCLM) methods with one-line luminance sample line in order to reduce the luminance line buffer
- Experimental results show that the proposed method yields BD-rate loss of 0.02%, 0.23%, and 0.22% for three color components on average over VTM2.0.1 with CCLM, respectively
- It is suggested to consider the proposed CCLM in the VTM

[JVET-L0066]
CE3-related:
**One-line MMLM for reduction
of reference sample lines**

Kwangwoon University (KWU)

Introduction

- In BMS-2.0.1
 - MMLM (Multi Model Linear Model) mode downsample four neighboring reconstructed luminance sample lines to two lines in the down-sampling process
- In this contribution
 - One-line MMLM that uses one reconstructed luminance sample line at the upper adjacent to the current PU in order to reduce a luminance line buffer

Introduction

- The down-sampled luminance sample value (Rec'_L) for neighboring and current reconstructed luminance samples is computed as

$$\begin{aligned} \text{Rec}'_L[x, y] = & ((\text{Rec}_L[2x - 1, -2] + 2 \cdot \text{Rec}_L[2x, -2] + \text{Rec}_L[2x + 1, -2]) \\ & + (\text{Rec}_L[2x - 1, -1] + 2 \cdot \text{Rec}_L[2x, -1] + \text{Rec}_L[2x + 1, -1]) + 4) \gg 3, \\ & 0 \leq x < W, \quad 0 < y \leq -2. \end{aligned}$$

- If the top-left PU of the current PU is not available, the down-sampled luminance sample value at the point $[0, y]$ is computed as

$$\text{Rec}'_L[0, y] = \left(\begin{array}{c} \text{Rec}_L[0, 2y] \\ \text{Rec}_L[0, 2y - 1] + 1 \end{array} \right) \gg 1, \quad 0 < y \leq -2$$

Proposed Method

- In the proposed MMLM method
 - The down-sampled luminance samples for above reconstructed sample line are computed by

$$\text{Rec}'_L[x, -1] = (\text{Rec}_L[2x - 1, -1] + 2 \cdot \text{Rec}_L[2x, -1] + \text{Rec}_L[2x + 1, -1] + 2) \gg 2, \\ 0 < x < W.$$

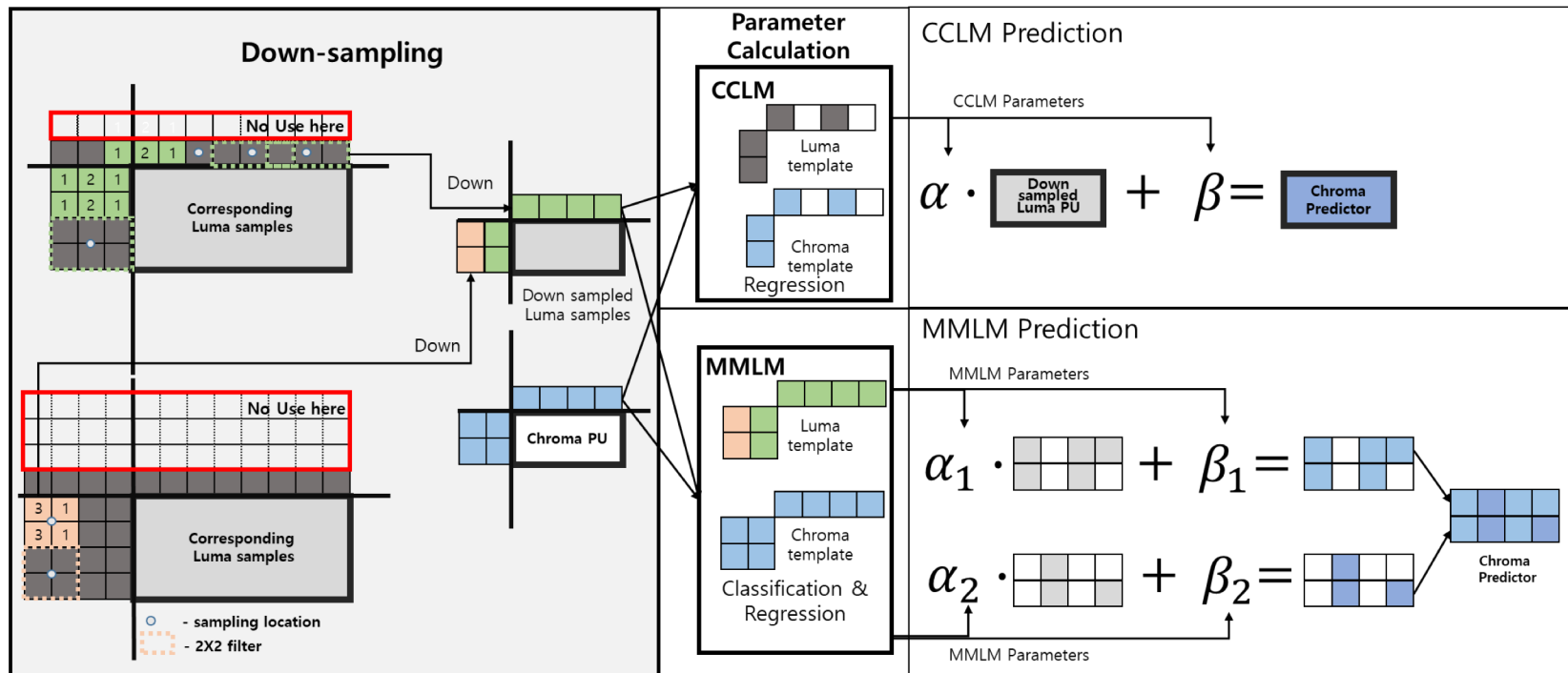
- If the left PU of the current PU is not available, the down-sampled luminance sample value computed as

$$\text{Rec}'_L[0, -1] = (3 \cdot \text{Rec}_L[0, -1] + \text{Rec}_L[1, -1] + 2) \gg 2.$$

- Four left reconstructed lines are also used in computing the CCLM and MMLM parameters, as the CCLM of BMS 2.0.1. For chroma sample prediction, the same algorithm to CCLM of BMS 2.0.1 is used

Proposed Method

- Diagram of the proposed One-line MMLM method



Comparison of RD performance

- Table 1. RD performance of VTM-2.0.1+CbtoCr+MMLM

Reference: BMS-2.01_vtm Tested: MMLM + CbtoCr	All Intra Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	-0.91%	-4.41%	-5.61%	103%	101%
Class A2	-0.50%	-4.00%	-1.62%	106%	101%
Class B	-0.34%	-4.35%	-5.12%	102%	100%
Class C	-0.49%	-5.18%	-4.55%	104%	100%
Class E	-0.31%	-4.52%	-3.89%	114%	100%
Overall	-0.49%	-4.52%	-4.29%	105%	100%
Class D	-0.32%	-4.76%	-3.89%	106%	99%

- Table 2. RD performance of VTM-2.0.1+CbtoCr+One-line MMLM

Reference: BMS-2.01_vtm Tested: One-line MMLM + CbtoCr	All Intra Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	-0.81%	-3.40%	-4.91%	97%	101%
Class A2	-0.45%	-3.66%	-1.32%	102%	101%
Class B	-0.32%	-3.99%	-4.55%	102%	100%
Class C	-0.42%	-4.71%	-3.98%	105%	100%
Class E	-0.30%	-4.42%	-3.83%	114%	100%
Overall	-0.44%	-4.07%	-3.83%	104%	100%
Class D	-0.29%	-4.17%	-3.58%	106%	98%

Comparison of RD performance

- Table 3. RD performance of VTM-2.0.1+MMLM

Reference: BMS-2.01_vtm Tested: BMS-2.0.1 + MMLM	All Intra Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	-0.86%	-3.76%	-5.15%	105%	102%
Class A2	-0.20%	-2.46%	-1.01%	107%	101%
Class B	-0.24%	-3.14%	-3.34%	103%	102%
Class C	-0.33%	-3.20%	-2.89%	107%	100%
Class E	-0.07%	-1.53%	-0.72%	116%	101%
Overall	-0.33%	-2.87%	-2.72%	107%	101%
Class D	-0.14%	-2.23%	-2.16%	107%	106%

- Table 4. RD performance of VTM-2.0.1+One-line MMLM

Reference: BMS-2.01_vtm Tested: One-line MMLM	All Intra Main10				
	Over VTM-2.0.1				
	Y	U	V	EncT	DecT
Class A1	-0.75%	-2.67%	-4.49%	98%	100%
Class A2	-0.13%	-2.04%	-0.73%	103%	102%
Class B	-0.21%	-2.73%	-2.75%	101%	102%
Class C	-0.24%	-2.58%	-2.22%	108%	101%
Class E	-0.06%	-1.56%	-0.66%	101%	100%
Overall	-0.27%	-2.38%	-2.23%	102%	101%
Class D	-0.13%	-1.81%	-1.77%	113%	104%

Conclusion

- This contribution proposes a modified Multi Model Linear Model (MMLM) which uses one-line buffer for luma in down-sampling process
- Experimental results show an average BD-rate gain 0.27%, 2.38% and 2.23% for three components on over BMS-2.0.1 with vtm config., respectively
- It is suggested to consider the proposed MMLM in the CE

THANK YOU

Q&A