JCTVC-H0280 CE10.2.1: Reducing one pixel line buffer by modified deblocking filter for horizontal LCU boundaries

Chih-Wei Hsu, Ching-Yeh Chen,
Yu-Wen Huang, Shawmin Lei (MediaTek)
Masaru Ikeda, Teruhiko Suzuki (Sony)

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Summary

- This contribution presents modified vertical filtering with reading 3 pixels and writing 2 pixels (R3W2) in deblocking
  - In HM5.0:
    - R4W3 filtering is applied to all boundaries
  - In this proposal:
    - R3W2 filtering is applied to only horizontal boundaries
    - R4W3 filtering is applied to the rest boundaries

- This proposal can save one pixel line buffer for deblocking filter

- BD-bitrates and subjective quality are kept the same level as HM5.0
  - Average BD-bitrates show 0.0% in all conditions with unchanged run-time

Introduction

- Line buffer issue:
  - HEVC has 3 loop filters (DF/SAO/ALF) and totally requires a lot of line buffers for 4K coding in LCU-based processing.
  - In last Geneva, VB processing was adopted for ALF line buffer reduction, but DF still require 4 and 2 lines for both luma and chroma respectively

- Therefore more reduction is desired for DF

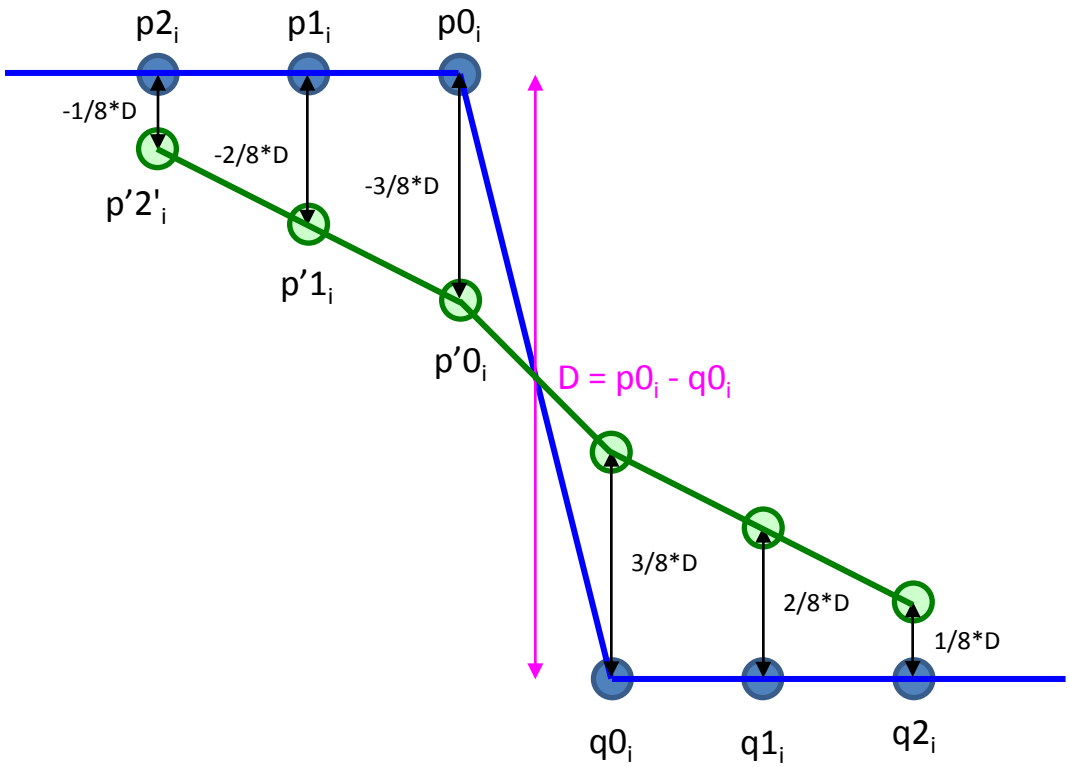
Proposed method

- R3W2 filtering is applied to only horizontal LCU boundaries
- Strong/weak selection
  - Use $p2_i$ instead of $p3_i$

    $d < (\beta>>2)$ and $(|p2_i - p0_i| + |q0i - q'3_i|) < (\beta>>3)$ and $|p'0_i - q0_i| < ((5*tc+1)>>1)$
- Strong filter
  - 2 pixels above horizontal LCU boundaries are filtered
  - Filter coefficient for only 1 pixel is modified to keep the visual quality
    - The gate size is estimated at 210 gate under TSMC 65nm LP Multi Vth process (200MHz with 45% margin) and very small.

Proposed method

- Currently strong filter is shown as green waveform

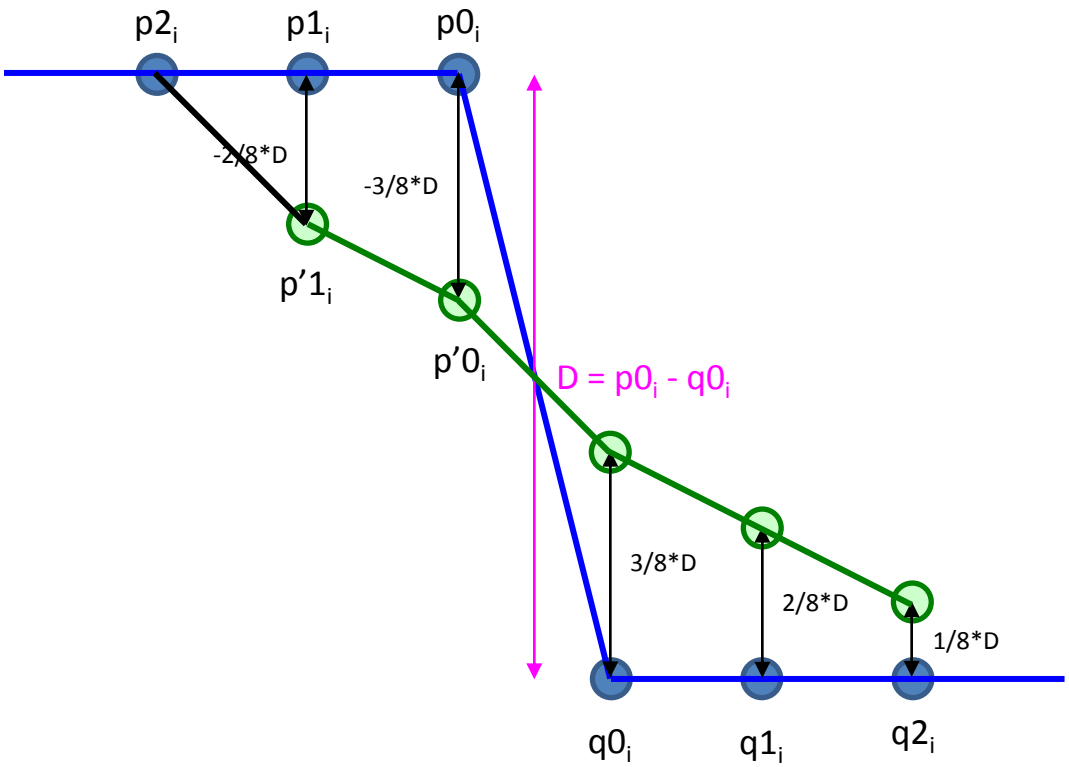


	$p3_0$	$p3_1$	$p3_2$	$p3_3$	$p3_4$	$p3_5$	$p3_6$	$p3_7$
	$p2_0$	$p2_1$	$p2_2$	$p2_3$	$p2_4$	$p2_5$	$p2_6$	$p2_7$
A	$p1_0$	$p1_1$	$p1_2$	$p1_3$	$p1_4$	$p1_5$	$p1_6$	$p1_7$
	$p0_0$	$p0_1$	$p0_2$	$p0_3$	$p0_4$	$p0_5$	$p0_6$	$p0_7$
	$q0_0$	$q0_1$	$q0_2$	$q0_3$	$q0_4$	$q0_5$	$q0_6$	$q0_7$
B	$q1_0$	$q1_1$	$q1_2$	$q1_3$	$q1_4$	$q1_5$	$q1_6$	$q1_7$
	$q2_0$	$q2_1$	$q2_2$	$q2_3$	$q2_4$	$q2_5$	$q2_6$	$q2_7$
	$q3_0$	$q3_1$	$q3_2$	$q3_3$	$q3_4$	$q3_5$	$q3_6$	$q3_7$

Proposed method

- Currently strong filter is shown as green waveform
- p2 is not filtered in case of R3W2

  ⇒ Waveform between $p2_i$ and $p0'_i$ is not smoothed

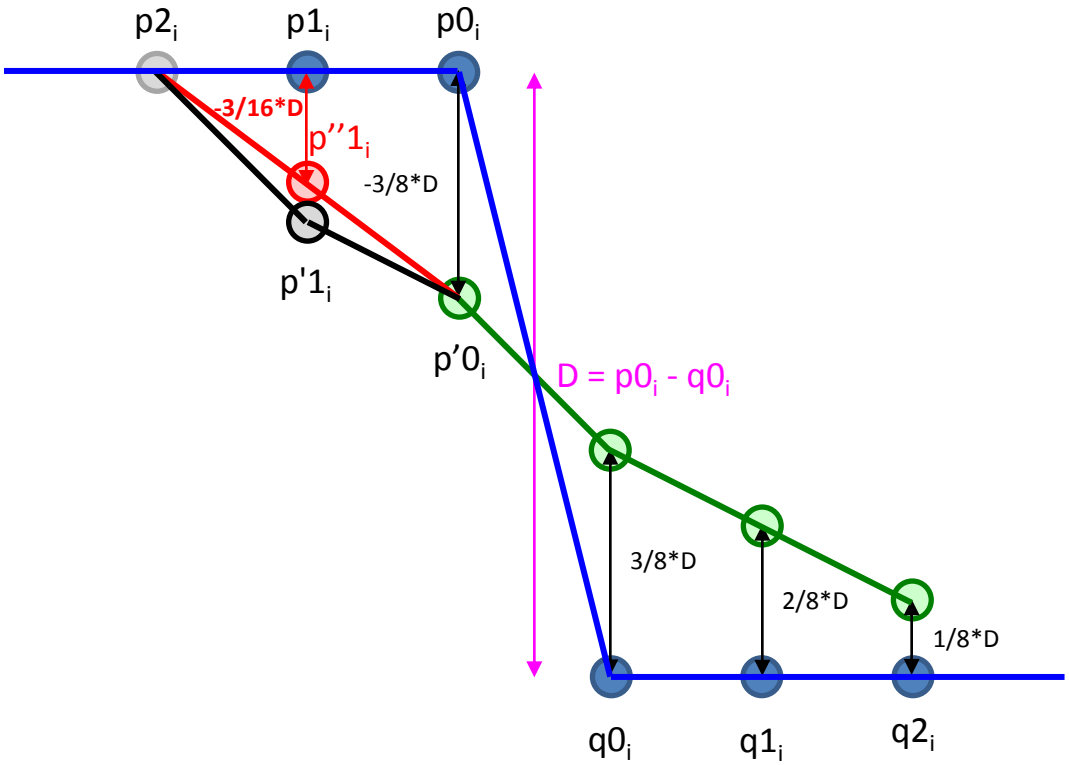


	$p3_0$	$p3_1$	$p3_2$	$p3_3$	$p3_4$	$p3_5$	$p3_6$	$p3_7$
	$p2_0$	$p2_1$	$p2_2$	$p2_3$	$p2_4$	$p2_5$	$p2_6$	$p2_7$
A	$p1_0$	$p1_1$	$p1_2$	$p1_3$	$p1_4$	$p1_5$	$p1_6$	$p1_7$
	$p0_0$	$p0_1$	$p0_2$	$p0_3$	$p0_4$	$p0_5$	$p0_6$	$p0_7$
	$q0_0$	$q0_1$	$q0_2$	$q0_3$	$q0_4$	$q0_5$	$q0_6$	$q0_7$
B	$q1_0$	$q1_1$	$q1_2$	$q1_3$	$q1_4$	$q1_5$	$q1_6$	$q1_7$
	$q2_0$	$q2_1$	$q2_2$	$q2_3$	$q2_4$	$q2_5$	$q2_6$	$q2_7$
	$q3_0$	$q3_1$	$q3_2$	$q3_3$	$q3_4$	$q3_5$	$q3_6$	$q3_7$

Proposed method

- Currently strong filter is shown as green waveform
- p2 is not filtered in case of R3W2

  ⇒ Waveform between $p2_i$ and $p0'_i$ is not smoothed
- Modify $p'1_i$ to p''_1 to smooth the waveform



	$p3_0$	$p3_1$	$p3_2$	$p3_3$	$p3_4$	$p3_5$	$p3_6$	$p3_7$
	$p2_0$	$p2_1$	$p2_2$	$p2_3$	$p2_4$	$p2_5$	$p2_6$	$p2_7$
A	$p1_0$	$p1_1$	$p1_2$	$p1_3$	$p1_4$	$p1_5$	$p1_6$	$p1_7$
	$p0_0$	$p0_1$	$p0_2$	$p0_3$	$p0_4$	$p0_5$	$p0_6$	$p0_7$
	$q0_0$	$q0_1$	$q0_2$	$q0_3$	$q0_4$	$q0_5$	$q0_6$	$q0_7$
B	$q1_0$	$q1_1$	$q1_2$	$q1_3$	$q1_4$	$q1_5$	$q1_6$	$q1_7$
	$q2_0$	$q2_1$	$q2_2$	$q2_3$	$q2_4$	$q2_5$	$q2_6$	$q2_7$
	$q3_0$	$q3_1$	$q3_2$	$q3_3$	$q3_4$	$q3_5$	$q3_6$	$q3_7$

Experimental results

- BD-bitrates and run-time are similar with HM5.0
- The visual quality for sequences including class-F and internal's is similar with HM5.0 in internal viewing

	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%
Class F						
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Enc Time[%]	100%			99%		
Dec Time[%]	99%			99%		

	Low delay P HE			Low delay P LC		
	Y	U	V	Y	U	V
Class A						
Class B	0.0%	0.1%	-0.3%	0.0%	0.1%	-0.1%
Class C	0.1%	-0.1%	-0.2%	0.0%	0.1%	0.1%
Class D	0.0%	0.2%	-0.2%	-0.1%	-0.5%	0.4%
Class E	0.0%	0.0%	0.3%	0.0%	-0.6%	-0.4%
Class F						
Overall	0.0%	0.0%	-0.1%	0.0%	-0.2%	0.0%
	0.0%	0.0%	-0.1%	0.0%	-0.2%	d
Enc Time[%]	100%			101%		
Dec Time[%]	99%			102%		

	Random Access HE			Random Access LC			Random Access HE-10		
	Y	U	V	Y	U	V	Y	U	V
Class A	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%
Class B	0.0%	0.0%	0.0%	0.0%	0.1%	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%	-0.1%	-0.1%	0.0%	0.0%	0.0%			
Class E									
Class F									
Overall	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Enc Time[%]	100%			100%			100%		
Dec Time[%]	100%			99%			100%		

Conclusions

- MediaTek and Sony propose R3W2 technique to reduce one pixel line buffer
- The average experimental results show 0.0% for all conditions with unchanged run-time
- The subjective quality is kept as the same level as HM5.0