

# JCTVC-F215 Vertical tap length reduction to reduce line memory in deblocking filter

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- Introduction
- Proposal
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- To reduce the line memory required in deblocking filter
  - LCU-based processing needs the line memory, which is 4 lines in HM-3.0
  - Pixel line buffers proportional to the picture width are required
    - One line memory for 4K image (3840x2160) corresponds to two line memories for HD image (1920x1080) in AVC

- Vertical tap length reduction
  - Using sample  $p1_i$  as a substitute for sample  $p3_i$  for all horizontal edges (with the same filter unit)

$$p0'_i = \text{Clip1}_Y( ( p2_i + 2*p1_i + 2*p0_i + 2*q0_i + q1_i + 4 ) \gg 3 )$$

$$p1'_i = \text{Clip1}_Y( ( p2_i + p1_i + p0_i + q0_i + 2 ) \gg 2 )$$

$$p2'_i = \text{Clip1}_Y( ( 2*\mathbf{p3}_i + 3*p2_i + p1_i + p0_i + q0_i + 4 ) \gg 3 )$$

$$q0'_i = \text{Clip1}_Y( ( p1_i + 2*p0_i + 2*q0_i + 2*q1_i + q2_i + 4 ) \gg 3 )$$

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

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|                 |                 |                 |                 |                 |                 |                 |                 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
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| $q0_0$          | $q0_1$          | $q0_2$          | $q0_3$          | $q0_4$          | $q0_5$          | $q0_6$          | $q0_7$          |
| $q1_0$          | $q1_1$          | $q1_2$          | $q1_3$          | $q1_4$          | $q1_5$          | $q1_6$          | $q1_7$          |
| $q2_0$          | $q2_1$          | $q2_2$          | $q2_3$          | $q2_4$          | $q2_5$          | $q2_6$          | $q2_7$          |
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One line reduction

|                 |                 |                 |                 |                 |                 |                 |                 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| <del>p0</del>   | <del>p1</del>   | <del>p2</del>   | <del>p3</del>   | <del>p4</del>   | <del>p5</del>   | <del>p6</del>   | <del>p7</del>   |
| p2 <sub>0</sub> | p2 <sub>1</sub> | p2 <sub>2</sub> | p2 <sub>3</sub> | p2 <sub>4</sub> | p2 <sub>5</sub> | p2 <sub>6</sub> | p2 <sub>7</sub> |
| p1 <sub>0</sub> | p1 <sub>1</sub> | p1 <sub>2</sub> | p1 <sub>3</sub> | p1 <sub>4</sub> | p1 <sub>5</sub> | p1 <sub>6</sub> | p1 <sub>7</sub> |
| p0 <sub>0</sub> | p0 <sub>1</sub> | p0 <sub>2</sub> | p0 <sub>3</sub> | p0 <sub>4</sub> | p0 <sub>5</sub> | p0 <sub>6</sub> | p0 <sub>7</sub> |
| q0 <sub>0</sub> | q0 <sub>1</sub> | q0 <sub>2</sub> | q0 <sub>3</sub> | q0 <sub>4</sub> | q0 <sub>5</sub> | q0 <sub>6</sub> | q0 <sub>7</sub> |
| q1 <sub>0</sub> | q1 <sub>1</sub> | q1 <sub>2</sub> | q1 <sub>3</sub> | q1 <sub>4</sub> | q1 <sub>5</sub> | q1 <sub>6</sub> | q1 <sub>7</sub> |
| q2 <sub>0</sub> | q2 <sub>1</sub> | q2 <sub>2</sub> | q2 <sub>3</sub> | q2 <sub>4</sub> | q2 <sub>5</sub> | q2 <sub>6</sub> | q2 <sub>7</sub> |
| q3 <sub>0</sub> | q3 <sub>1</sub> | q3 <sub>2</sub> | q3 <sub>3</sub> | q3 <sub>4</sub> | q3 <sub>5</sub> | q3 <sub>6</sub> | q3 <sub>7</sub> |

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$$= \text{Clip1}_Y( ( 3*p2_i + \mathbf{3*p1_i} + p0_i + q0_i + 4 ) \gg 3 )$$

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No special control  
because of applying to all horizontal edges

One line reduction

|                 |                 |                 |                 |                 |                 |                 |                 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| <del>p0</del>   | <del>p1</del>   | <del>p2</del>   | <del>p3</del>   | <del>p4</del>   | <del>p5</del>   | <del>p6</del>   | <del>p7</del>   |
| p2 <sub>0</sub> | p2 <sub>1</sub> | p2 <sub>2</sub> | p2 <sub>3</sub> | p2 <sub>4</sub> | p2 <sub>5</sub> | p2 <sub>6</sub> | p2 <sub>7</sub> |
| p1 <sub>0</sub> | p1 <sub>1</sub> | p1 <sub>2</sub> | p1 <sub>3</sub> | p1 <sub>4</sub> | p1 <sub>5</sub> | p1 <sub>6</sub> | p1 <sub>7</sub> |
| p0 <sub>0</sub> | p0 <sub>1</sub> | p0 <sub>2</sub> | p0 <sub>3</sub> | p0 <sub>4</sub> | p0 <sub>5</sub> | p0 <sub>6</sub> | p0 <sub>7</sub> |
| q0 <sub>0</sub> | q0 <sub>1</sub> | q0 <sub>2</sub> | q0 <sub>3</sub> | q0 <sub>4</sub> | q0 <sub>5</sub> | q0 <sub>6</sub> | q0 <sub>7</sub> |
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| q3 <sub>0</sub> | q3 <sub>1</sub> | q3 <sub>2</sub> | q3 <sub>3</sub> | q3 <sub>4</sub> | q3 <sub>5</sub> | q3 <sub>6</sub> | q3 <sub>7</sub> |

- Vertical tap reduction in deblocking filter
  - The difference of both BD-rate and run time with HM-3.0 is negligible
  - The difference in subjective quality is also negligible for the same sequences as CE12

|             | Intra     |           |           | Intra LC  |           |           |
|-------------|-----------|-----------|-----------|-----------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate | U BD-rate | V BD-rate |
| 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       |
| All         | 0.0       | 0.0       | 0.0       | 0.0       | 0.0       | 0.0       |
| Enc Time[%] | 100%      |           |           | 101%      |           |           |
| Dec Time[%] | 100%      |           |           | 100%      |           |           |

|             | Random access |           |           | Random access LC |           |           |
|-------------|---------------|-----------|-----------|------------------|-----------|-----------|
|             | Y BD-rate     | U BD-rate | V BD-rate | Y BD-rate        | U BD-rate | V BD-rate |
| Class A     | -0.1          | -0.1      | 0.0       | -0.1             | 0.0       | 0.1       |
| Class B     | 0.0           | -0.1      | 0.1       | 0.0              | 0.0       | 0.0       |
| Class C     | 0.0           | 0.1       | 0.0       | 0.0              | 0.0       | -0.1      |
| Class D     | 0.0           | -0.1      | -0.1      | 0.0              | 0.0       | 0.0       |
| Class E     |               |           |           |                  |           |           |
| All         | 0.0           | -0.1      | 0.0       | 0.0              | 0.0       | 0.0       |
| Enc Time[%] | 100%          |           |           | 100%             |           |           |
| Dec Time[%] | 100%          |           |           | 100%             |           |           |

|             | Low delay |           |           | Low delay LC |           |           |
|-------------|-----------|-----------|-----------|--------------|-----------|-----------|
|             | Y BD-rate | U BD-rate | V BD-rate | Y BD-rate    | U BD-rate | V BD-rate |
| Class A     |           |           |           |              |           |           |
| Class B     | 0.0       | 0.2       | 0.0       | 0.0          | -0.1      | -0.3      |
| Class C     | 0.0       | -0.1      | -0.1      | 0.0          | 0.2       | 0.0       |
| Class D     | 0.0       | 0.1       | 0.1       | 0.0          | -0.2      | 0.0       |
| Class E     | 0.2       | 0.0       | 0.1       | 0.0          | -0.2      | -0.3      |
| All         | 0.0       | 0.1       | 0.0       | 0.0          | -0.1      | -0.2      |
| Enc Time[%] | 100%      |           |           | 100%         |           |           |
| Dec Time[%] | 100%      |           |           | 100%         |           |           |



- We, Sony, would like to recommend to adopt “vertical tap length reduction” into the next HM
  - The difference of both BD-Rate, run time and subjective quality is negligible.
  - The modification is very simple.
- This proposal is cross-verified by Panasonic
  - JCTVC-F444: Cross-check results for Sony’s proposal JCTVC-F215



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