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| *Title:* | **Deblocking Filter Simplifications** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution addresses the simplification of the deblocking filter. It is proposed to modify the weak filter delta and the strong/weak filter decision. Modifying the weak filter delta results in BD-rate savings of -0.2% for all-intra, -0.1% for random access, and -0.2% for low delay B. The number of strong/weak filter decisions for an edge segment is reduced from eight to two.

# Introduction

The following provides a brief overview of the weak filter and the strong/weak filter decision in HM4 [1].

* Deblocking weak filter:

Δ =  ( 9\*(q0-p0) - 3\*(q1-p1) + 8 )/16

Δ = Clip( -tC, tC, Δ ) (tC is threshold parameter, depending on quantization parameter)

p0’ = p0 + Δ

q0’ = q0 - Δ

Δp = Clip( - tC/2, tC/2, ( (p2 + p0 + 1)/2 - p1 + Δ)/2 )

p1’ = p1 + Δp (modification of p1 depending on decision conditions)

Δq = Clip( - tC/2, tC/2, ( (q2 + q0 + 1)/2 - q1 - Δ)/2 )

q1’ = q1 + Δq (modification of q1 depending on decision conditions)

* Strong/weak filter decision:



* + Computed for each line/column of 8-sample edge segment ( i=0…7 )
  + d is computed only once per edge segment
  + tC and β are threshold parameters depending on QP

# Proposed Simplifications

## Weak Filter Delta Simplification

Modified coefficients for computation of delta, saving one multiplication (\*3):

Δ =  ( 3\*(q0-p0) - (q1-p1) + 4 )/8

## Strong/Weak Decision Simplification



Use decision result of line i=2 for first 4 lines/columns of 8-sample edge segment and use decision result of line i=5 for second 4 lines/columns of 8-sample edge segment.

# Objective Results

The following results are obtained according to the HM4 common test conditions (JCTVC-F900). The execution times are measured in a heterogeneous computing environment.

## Weak Filter Delta Simplification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | 0.0% |
| Class B | -0.3% | 0.0% | 0.0% | -0.2% | 0.0% | 0.0% |
| Class C | -0.2% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% |
| Class D | -0.2% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% |
| Class E | -0.2% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% |
| **Overall** | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | 0.0% |
|  | -0.2% | 0.0% | 0.0% | -0.2% | 0.0% | 0.0% |
| Enc Time[%] | 100% | | | 97% | | |
| Dec Time[%] | 99% | | | 99% | | |
|  |  |  |  |  |  |  |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | -0.1% | -0.1% | -0.2% | -0.1% | 0.1% | -0.1% |
| Class B | -0.2% | 0.0% | 0.0% | -0.1% | -0.1% | 0.1% |
| Class C | -0.1% | -0.1% | 0.0% | -0.1% | 0.0% | 0.1% |
| Class D | -0.1% | 0.1% | 0.0% | -0.1% | -0.2% | 0.0% |
| Class E |  |  |  |  |  |  |
| **Overall** | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% |
|  | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% |
| Enc Time[%] | 96% | | | 100% | | |
| Dec Time[%] | 97% | | | 100% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | -0.2% | -0.2% | -0.3% | -0.1% | 0.0% | 0.1% |
| Class C | -0.1% | -0.1% | -0.1% | -0.1% | 0.2% | -0.2% |
| Class D | -0.2% | 0.1% | 0.2% | -0.1% | 0.1% | 0.0% |
| Class E | -0.3% | -0.2% | 0.8% | -0.2% | 0.3% | -0.3% |
| **Overall** | -0.2% | -0.1% | 0.1% | -0.1% | 0.1% | -0.1% |
|  | -0.2% | -0.1% | 0.1% | -0.1% | 0.1% | -0.1% |
| Enc Time[%] | 97% | | | 99% | | |
| Dec Time[%] | 98% | | | 97% | | |

## Strong/Weak Filter Decision Simplification

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **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 | 0.1% | 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 | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| **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[%] | 101% | | | 96% | | |
| Dec Time[%] | 97% | | | 100% | | |
|  |  |  |  |  |  |  |
|  | **Random Access HE** | | | **Random Access LC** | | |
|  | Y | U | V | Y | U | V |
| Class A | 0.0% | -0.2% | -0.3% | 0.1% | 0.0% | 0.1% |
| Class B | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.1% | 0.0% | -0.1% | 0.0% | 0.0% | -0.1% |
| Class D | 0.1% | 0.0% | -0.1% | 0.1% | -0.1% | 0.1% |
| Class E |  |  |  |  |  |  |
| **Overall** | 0.1% | -0.1% | -0.1% | 0.0% | 0.0% | 0.0% |
|  | 0.1% | -0.1% | -0.1% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 96% | | | 100% | | |
| Dec Time[%] | 98% | | | 98% | | |
|  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B LC** | | |
|  | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |
| Class B | 0.1% | -0.1% | -0.1% | 0.1% | 0.0% | 0.3% |
| Class C | 0.1% | 0.0% | -0.1% | 0.0% | 0.2% | -0.2% |
| Class D | 0.1% | 0.0% | -0.1% | 0.0% | 0.1% | -0.1% |
| Class E | 0.3% | 0.1% | 0.8% | 0.1% | -0.1% | 0.1% |
| **Overall** | 0.1% | 0.0% | 0.1% | 0.1% | 0.1% | 0.1% |
|  | 0.1% | 0.0% | 0.1% | 0.1% | 0.0% | 0.0% |
| Enc Time[%] | 97% | | | 95% | | |
| Dec Time[%] | 98% | | | 97% | | |

# Conclusion

This contribution proposed simplifying the weak filter delta, which results in BD-rate savings of -0.2% for all-intra, -0.1% for random access, -0.2% for low delay B. The number of times the strong/weak filter decision is computed is reduced from 8 to 2 for an edge segment, which is split into two halves of 4 lines each that is processed with the strong or weak filter.

# References

1. B. Bross, W.-J. Han, J.-R. Ohm, G. J. Sullivan, T. Wiegand, “WD4: Working Draft 4 of High-Efficiency Video Coding,” 6th JCT-VC Meeting, Turin, Italy, July 2011, Doc. JCTVC-F803

# Working Draft

The following are working draft changes based on WD4\_d5.

## Weak Filter Simplification

“**8.6.1.4.5 Filtering process for a luma sample**

…

– Otherwise, the following weak filtering applies while nDp and nDq are set equal to 0:

Δ = ( 3 \* ( q0 –  p0 ) –  ( q1 – p1 ) +  4) >> 3

…”

## Strong/Weak Decision Simplification

“**8.6.1.4.1 Decision process for luma block edge**

…

1. If bS is not equal to 0 and d is less than β, the following ordered steps apply:
2. for sample locations ( xC + xB, yC + yB + k ), k = 2,5, the following ordered steps apply:
   1. The decision process for a luma sample specified in subclause 8.6.1.4.4 is invoked with sample values pi,k, qi,k with i = 0..3, the boundary filtering strength bS and the variables d, β and tC as inputs and a decision dSam as output.
   2. If k equals 2, the variable dS[i] with i = 0...3 is set equal to dSam
   3. If k equals 5, the variable dS[i] with i = 4...7 is set equal to dSam
3. The variable dE is set equal to 1.
4. If dp is less than ( β + ( β >> 1 ) ) >> 3, the variable dEp1 is set equal to 1.
5. If dq is less than ( β + ( β >> 1 ) ) >> 3, the variable dEq1 is set equal to 1.

…

1. If bS is not equal to 0 and d is less than β, the following ordered steps apply:
2. For each sample location ( xC + xB + k, yC + yB ), k = 2,5, the following ordered steps apply:
   1. The decision process for a luma sample specified in subclause 8.6.1.4.4 is invoked with sample values pi,k, qi,k with i = 0..3, the boundary filtering strength bS and the variables d, β and tC as inputs and a decision dSam as output.
   2. If k equals 2, the variable dS[i] with i = 0...3 is set equal to dSam
   3. If k equals 5, the variable dS[i] with i = 4...7 is set equal to dSam
3. The variable dE is set equal to 1.
4. If dp is less than ( β + ( β >> 1 ) ) >> 3, the variable dEp1 is set equal to 1.
5. If dq is less than ( β + ( β >> 1 ) ) >> 3, the variable dEq1 is set equal to 1.

…”

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