CREATING THE LIVING NETWORK™

JVET-G0076
Bilateral filter simplification

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Introduction

- Bilateral filter was adopted in JEM-6.0, and it is applied to reconstructed luma samples
- Weight of bilateral filter for sample at position (k, l) when filtering a sample at (i, j):

$$\omega(i, j, k, l) = e^{\left(- \frac{(i-k)^2 + (j-l)^2}{2\sigma_d^2} - \frac{\left\| \tilde{x}_{ij} - \tilde{x}_{kl} \right\|^2}{2\sigma_r^2} \right)}$$

where $\tilde{x}_{ij}$ is the reconstructed samples at (i, j), σ_d is the spatial parameter, and σ_r is the range parameter

Proposed bilateral filter simplification

- New condition: Check if the inversed quantized transform coefficients of a CU have only one non-zero coefficient located at the DC position
  - Under this condition, residual samples $\hat{r}_{ij}$ are constant, i.e., $\hat{r}_{ij} = K$
  - Difference in reconstructed samples used in bilateral filter:

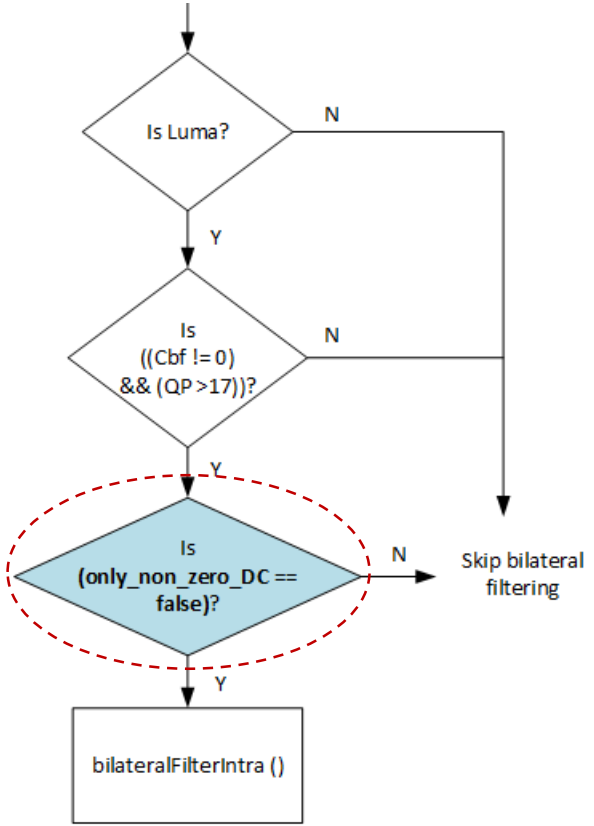
$$\begin{aligned}(\tilde{x}_{ij} - \tilde{x}_{kl}) &= (p_{ij} + \hat{r}_{ij}) - (p_{kl} + \hat{r}_{kl}) \\ &= (p_{ij} + K) - (p_{kl} + K) \\ &= (p_{ij} - p_{kl}),\end{aligned}$$

    where p_{ij} is prediction sample at position (i, j)

- Above difference is identical to the case when Cbf is zero ($K = 0$)
- Skip bilateral filtering under the new condition since bilateral filtering is skipped when Cbf=0

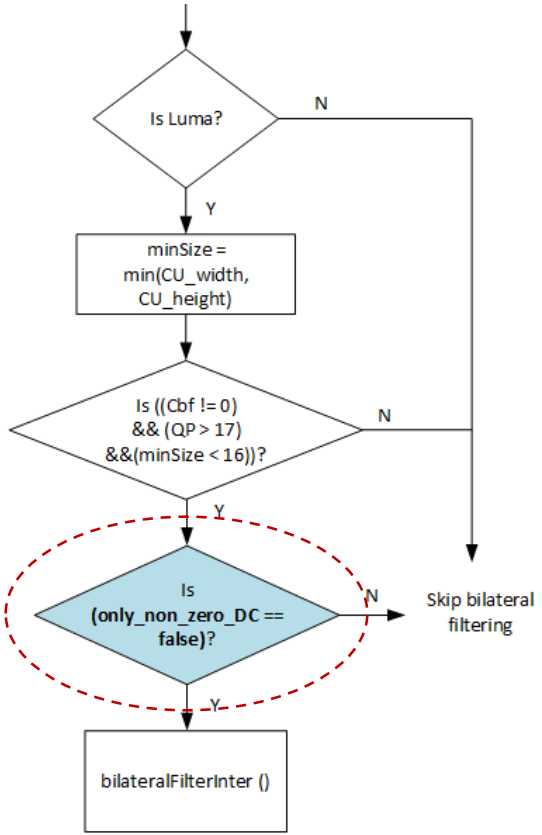
Bilateral filter simplification for intra-coded blocks

- Add one new condition: check if the inverse quantized *primary* transform coefficients contain only one non-zero coefficient located at the DC position



Bilateral filter simplification for inter-coded blocks

- Add one new condition: check if the inverse quantized transform coefficients contain only one non-zero coefficient located at the DC position – “only_non_zero_DC”



Results (1)

AI results compared to JEM-6.0 anchor

	Over HM-16.6-JEM-6.0 (parallel)				
	Y	U	V	EncT	DecT
Class A1	0.00%	-0.01%	0.02%	99%	99%
Class A2	0.04%	0.11%	0.00%	99%	99%
Class B	0.03%	-0.02%	-0.04%	100%	100%
Class C	0.05%	0.05%	0.05%	100%	99%
Class D	0.04%	-0.03%	-0.10%	100%	99%
Class E	0.04%	-0.01%	-0.09%	100%	100%
Overall	0.03%	0.01%	-0.02%	100%	99%

1% decoding speed-up

Results (2)

RA results compared to JEM-6.0 anchor

	Over HM-16.6-JEM-6.0 (parallel)				
	Y	U	V	EncT	DecT
Class A1	0.01%	0.01%	0.04%	100%	99%
Class A2	0.05%	-0.15%	-0.06%	100%	100%
Class B	0.00%	0.01%	-0.02%	100%	100%
Class C	0.04%	-0.06%	-0.09%	100%	100%
Class D	0.02%	0.06%	-0.33%	100%	100%
Class E	-	-	-	-	-
Overall	0.02%	-0.02%	-0.09%	100%	100%

Results (3)

LDB results compared to JEM-6.0 anchor

	Over HM-16.6-JEM-6.0 (parallel)				
	Y	U	V	EncT	DecT
Class A1	-	-	-	-	-
Class A2	-	-	-	-	-
Class B	0.03%	0.05%	-0.23%	100%	99%
Class C	0.00%	-0.18%	-0.38%	100%	100%
Class D	0.02%	0.08%	-0.09%	100%	100%
Class E	0.06%	0.42%	0.84%	100%	100%
Overall	0.02%	0.07%	-0.03%	100%	100%

Results (4)

LDP results compared to JEM-6.0 anchor

	Over HM-16.6-JEM-6.0 (parallel)				
	Y	U	V	EncT	DecT
Class A1	-	-	-	-	-
Class A2	-	-	-	-	-
Class B	-0.01%	-0.04%	-0.30%	100%	100%
Class C	0.02%	0.11%	-0.13%	100%	100%
Class D	0.02%	0.14%	-0.62%	100%	100%
Class E	-0.01%	-0.39%	0.46%	100%	100%
Overall	0.01%	-0.02%	-0.19%	100%	100%

Conclusion

- Proposed one simplification for the bilateral filter in JEM-6.0
- Bilateral filtering is skipped for a CU if it contains only one non-zero inverse quantized transform coefficient located at the DC position
- Simplification yields 1% decoding speed-up for AI, with average luma BD-rate loss up to 0.03% across all configurations

Thank Qualcomm for cross-checking the results (JVET-G0151)

Thank you!

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