JVET-M0241
CE9-related: A Simple gradient calculation at the CU boundary for BDOF

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Introduction

❑ VTM-3.0 BDOF

- ❖ Use **bi-linear filters** to generate additional samples in the extended region around the current CU

❑ CE9.1.1.c

- ❖ Only **use the prediction samples that are inside the current CU** for the BDOF derivation → **avoid the interpolation of the extended samples**
- ❖ apply **different gradient calculation method** for prediction samples on the CU boundaries and inside CU

❑ Proposal

- ❖ Only **use the prediction samples that are inside the current CU** for the BDOF derivation → avoid the interpolation of the extended samples
- ❖ **CU boundary samples are copied into the extended region** to generate prediction samples in the extended regions
- ❖ Apply **an identical gradient filter, [-1, 0, 1],** for prediction samples on the CU boundaries and inside CU

Proposed Method

❑ Proposed Method

❖ Before the gradient calculation, **the extended area's samples are padded with the samples on CU boundaries**

extended area sample padding

↓

gradient calculation (extended area gradient padding)

↓

~~extended area sample padding~~

↓

BIO parameter calculation

BDOF refinement process for the current CU (proposed method S/W)

$$\frac{\partial I^{(k)}}{\partial x}(i,j) = \begin{cases} \left(I^{(k)}(i+1,j) - I^{(k)}(i-1,j)\right) \gg 4 & 0 < i < W-1 \\ \left(I^{(k)}(i+1,j) - \boldsymbol{I^{(k)}(i,j)}\right) \gg 4 & i = 0 \\ \left(\boldsymbol{I^{(k)}(i,j)} - I^{(k)}(i-1,j)\right) \gg 4 & i = W-1 \end{cases}$$

$$\frac{\partial I^{(k)}}{\partial y}(i,j) = \begin{cases} \left(I^{(k)}(i,j+1) - I^{(k)}(i,j-1)\right) \gg 4 & 0 < j < H-1 \\ \left(I^{(k)}(i,j+1) - \boldsymbol{I^{(k)}(i,j)}\right) \gg 4 & j = 0 \\ \left(\boldsymbol{I^{(k)}(i,j)} - I^{(k)}(i,j-1)\right) \gg 4 & j = H-1 \end{cases}$$

❖ **No additional operations** are required for extended area's prediction samples

❖ Sample padding process is already included in BDOF to derive BIO parameter

❖ **MC interpolation process need not to be changed** to generate prediction samples in the extended region.

Experimental Results

❑ Anchor: VTM-3.0

	Random access Main10 Over VTM-3.0				
	Y	U	V	EncT	DecT
Class A1	0.06%	-0.04%	-0.03%	99%	99%
Class A2	0.12%	0.01%	0.00%	99%	98%
Class B	0.10%	0.03%	-0.04%	99%	98%
Class C	0.15%	0.01%	0.06%	99%	98%
Class E					
Overall	0.11%	0.01%	-0.01%	99%	98%
Class D	0.26%	-0.02%	0.12%	98%	97%
Class F	0.03%	0.00%	-0.02%	99%	99%

❑ Anchor: CE9.1.1c

	Random access Main10 Over CE9.1.1c				
	Y	U	V	EncT	DecT
Class A1	0.04%	-0.03%	-0.04%	100%	100%
Class A2	0.06%	0.02%	-0.01%	100%	100%
Class B	0.00%	0.02%	0.00%	100%	100%
Class C	-0.04%	-0.08%	-0.04%	100%	100%
Class E					
Overall	0.01%	-0.02%	-0.02%	100%	100%
Class D	-0.13%	-0.17%	-0.06%	100%	99%
Class F	0.00%	0.03%	-0.01%	100%	101%

Conclusion

- **We propose a simple gradient derivation method at CU boundaries** to avoid the interpolation of the extended samples
  - **CU boundary samples are padded to extended region** for generating prediction samples of extended region
  - **An identical gradient derivation** is applied to the samples on CU boundary and inside CU

$$\frac{\partial I^{(k)}}{\partial x}(i,j) = \left(I^{(k)}(i+1,j) - I^{(k)}(i-1,j)\right) \gg 4$$

$$\frac{\partial I^{(k)}}{\partial y}(i,j) = \left(I^{(k)}(i,j+1) - I^{(k)}(i,j\ -1)\right) \gg 4$$

  - **MC interpolation process need not to be changed** to generate prediction samples in the extended region.
- **Suggest to study in CE**
- **Thanks to Sharp for cross-checking**