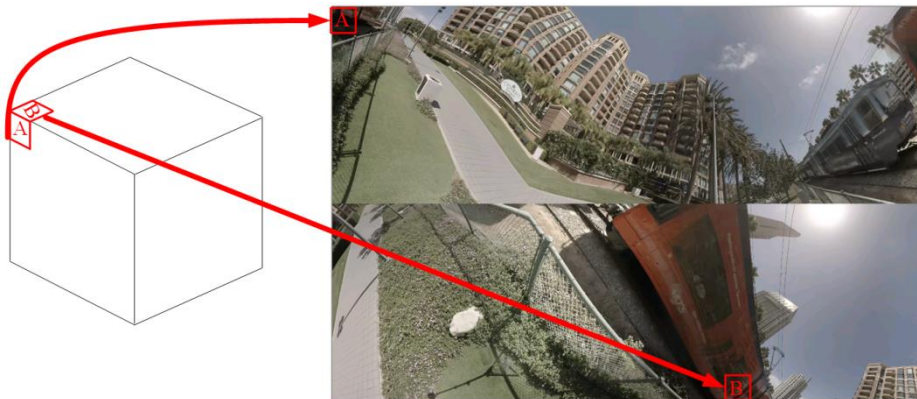


JVET-K0183

Face boundary filtering for 360° video

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Introduction



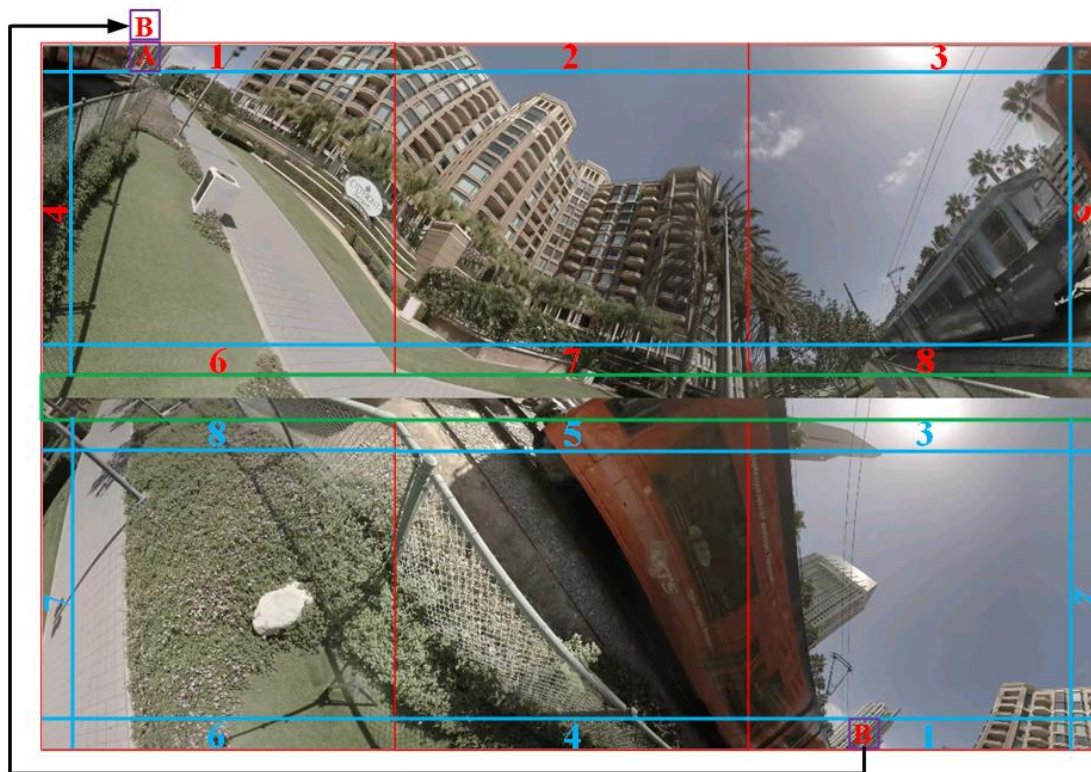
Blocks A and B are adjacent on the sphere but nonadjacent in the frame-packed image



Seam artifact in reconstructed viewport

- Coded blocks (adjacent on the sphere but nonadjacent in the frame-packed image) will cause seam artifacts in reconstructed viewport
- Propose a face boundary filtering method

Face boundary filter



Regions processed by proposed filtering method

- The proposed filter imitates the deblocking filter in HEVC
- Nonadjacent block which is adjacent on the sphere is fetched for face boundary filtering

Face boundary filter

- In-loop filtering
 - Boundary strength (BS) is determined by prediction modes of nonadjacent blocks (if intra, BS=2, else BS=1).
- Post filtering
 - BS is set a fixed strength of 1.
 - Slice QP is used to determine the parameters t_c and β .

Experimental Results

- Filtering face boundaries on PAU format
 - Based on 360Lib-6.0 with VTM
 - In-loop and post filtering are tested (anchor: PAU without filtering)

Sequence	E2E WS-PSNR					
	In-loop filtering			Post filtering		
	BD-rate(Y)	BD-rate(U)	BD-rate(V)	BD-rate(Y)	BD-rate(U)	BD-rate(V)
SkateboardInLot	-0.05%	0.11%	-0.05%	-0.05%	0.00%	0.00%
ChairLift	-0.05%	0.03%	-0.13%	-0.06%	0.00%	0.00%
KiteFlite	0.02%	-0.02%	-0.03%	0.00%	0.00%	0.00%
Harbor	0.04%	-0.02%	-0.06%	0.01%	0.00%	0.00%
Trolley	0.02%	0.01%	0.07%	0.01%	0.00%	0.00%
GasLamp	0.06%	0.04%	0.01%	0.03%	0.00%	0.00%
Balboa	-0.11%	0.02%	-0.34%	-0.05%	0.00%	0.00%
Broadway	-0.09%	-0.20%	0.04%	-0.05%	0.00%	0.00%
Landing2	-0.07%	-0.18%	-0.03%	-0.05%	0.00%	0.00%
BranCastle2	-0.05%	0.00%	-0.08%	-0.04%	0.00%	0.00%
Overall	-0.03%	-0.02%	-0.06%	-0.02%	0.00%	0.00%

Subjective results



(a)



(b)



(c)

Evil viewports of Trolley (QP=37, frame 143) in degree(-135, 35) (a) without filtering
(b) with in-loop filtering (c) with post filtering

Subjective results



(a)



(b)



(c)

Evil viewports of ChairLift (QP=37, frame 46) in degree(-135, 35) (a) without filtering (b) with in-loop filtering (c) with post filtering

Conclusion

- Face boundary filtering can improve the subjective quality significantly.
- The subjective and objective performance of in-loop filtering and post filtering are similar
- In order to keep the coding process of 360 video consistent with that of SDR video, we suggest using post filtering to resolve the seam artifacts

Thank you for your attention!