

SONY

m48915

[V-PCC] CE2.12 Report

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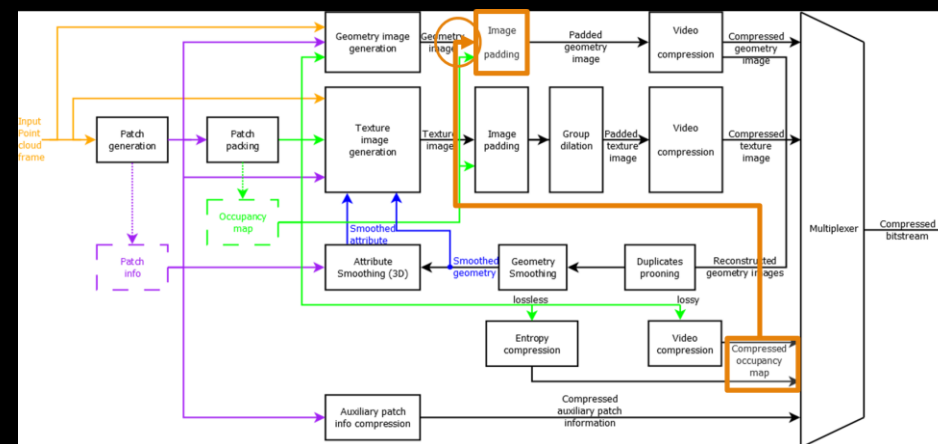
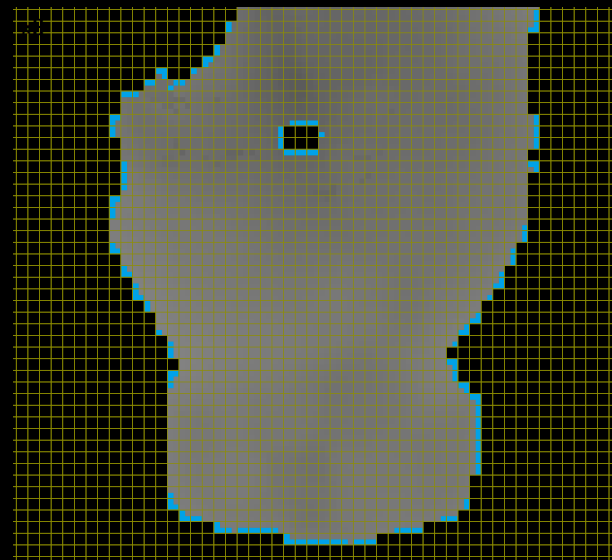
July 6, 2019

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CE2.12 on Visual Quality

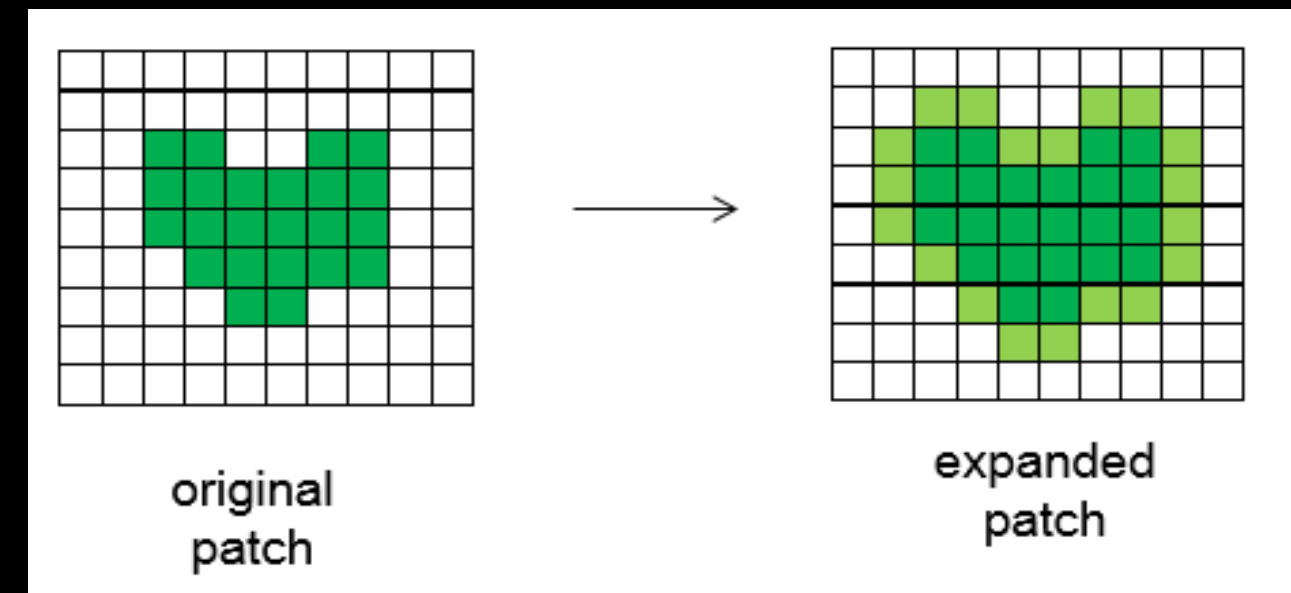
❖ 3D Geometry Padding (Sony)

- Propose to use the geometry padding to create new values that are closer to the original point cloud



❖ Patch Extension (ITRI)

- Extend the patches to reduce the holes



Patch Expansion (ITRI)

The code was cross-checked by Sony, we had a perfect match to all lossy conditions.

All frames results

C2_ai — lossy geometry, lossy attributes [all intra]

Class	Sequence	Geom. BD-TotGeomRate [%]		End-to-End BD-AttrRate [%]		
		D1	D2	Luma	Chroma Cb	Chroma Cr
cat2-A	8ivfbv2_loot_vox10	0.5%	1.6%	0.8%	0.4%	0.5%
	8ivfbv2_redandblack_vox10	0.6%	1.9%	1.0%	1.4%	1.3%
	8ivfbv2_soldier_vox10	0.8%	2.2%	1.4%	1.6%	1.5%
	queen	0.8%	1.6%	0.0%	-0.2%	-0.2%
cat2-B	8ivfbv2_longdress_vox10	0.5%	1.6%	0.8%	1.1%	1.0%
cat2-C	basketball_player_vox11	0.2%	1.2%	0.7%	0.9%	0.9%
	dancer_player_vox11	-0.1%	0.9%	0.3%	0.4%	-0.1%
Cat2-A average		0.7%	1.9%	0.8%	0.8%	0.7%
Cat2-B average		0.5%	1.6%	0.8%	1.1%	1.0%
Cat2-C average		0.0%	1.0%	0.5%	0.7%	0.4%
Overall average		0.5%	1.6%	0.7%	0.8%	0.7%

C2_ra — lossy geometry, lossy attributes [inter, random access]

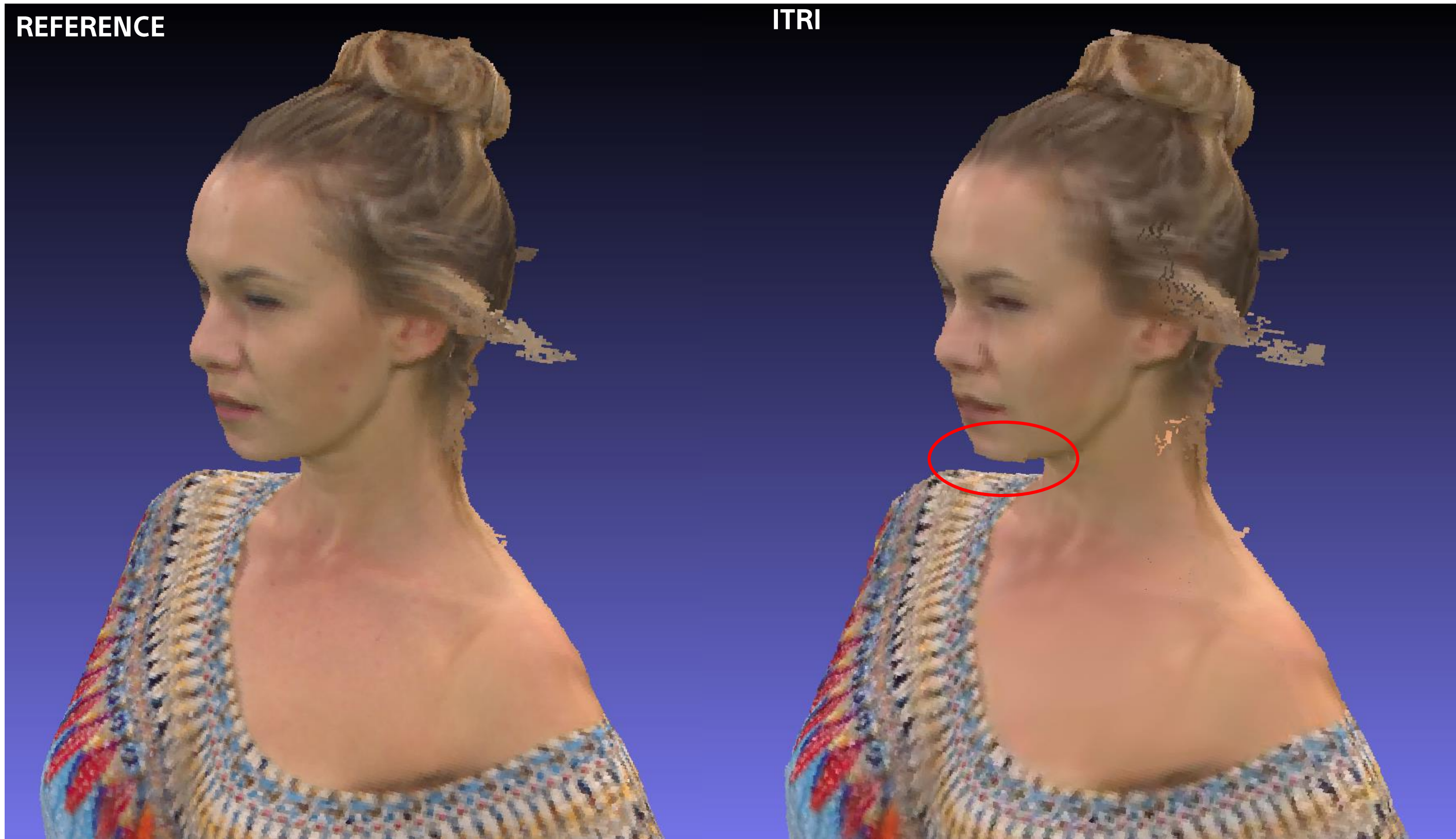
Class	Sequence	Geom. BD-TotGeomRate [%]		End-to-End BD-AttrRate [%]		
		D1	D2	Luma	Chroma Cb	Chroma Cr
cat2-A	8ivfbv2_loot_vox10	0.0%	1.0%	-1.1%	-1.8%	-1.7%
	8ivfbv2_redandblack_vox10	0.7%	2.0%	0.6%	0.8%	0.8%
	8ivfbv2_soldier_vox10	1.7%	2.7%	1.5%	0.8%	1.1%
	queen	1.1%	1.6%	0.2%	0.3%	-0.5%
cat2-B	8ivfbv2_longdress_vox10	0.5%	1.5%	0.4%	0.7%	0.5%
cat2-C	basketball_player_vox11	-0.2%	0.8%	0.6%	0.0%	2.1%
	dancer_player_vox11	-0.2%	0.8%	-0.2%	-0.2%	-0.9%
Cat2-A average		0.9%	1.8%	0.3%	0.0%	-0.1%
Cat2-B average		0.5%	1.5%	0.4%	0.7%	0.5%
Cat2-C average		-0.2%	0.8%	0.2%	-0.1%	0.6%
Overall average		0.5%	1.5%	0.3%	0.1%	0.2%

Geom. BD-TotalRate [%]		End-to-End BD-TotalRate [%]		
D1	D2	Luma	Chroma Cb	Chroma Cr
-0.3%	1.7%	0.9%	0.7%	0.7%
0.1%	2.2%	1.1%	1.5%	1.3%
0.1%	2.8%	1.4%	1.6%	1.5%
0.5%	1.7%	0.3%	0.1%	0.1%
0.0%	2.0%	0.8%	1.1%	1.0%
-0.5%	1.2%	0.8%	0.9%	0.9%
-0.8%	0.9%	0.4%	0.5%	0.2%
0.1%	2.1%	0.9%	1.0%	0.9%
0.0%	2.0%	0.8%	1.1%	1.0%
-0.6%	1.0%	0.6%	0.7%	0.5%
-0.1%	1.8%	0.8%	0.9%	0.8%

Geom. BD-TotalRate [%]		End-to-End BD-TotalRate [%]		
D1	D2	Luma	Chroma Cb	Chroma Cr
-0.7%	0.8%	-0.1%	-0.4%	-0.3%
0.2%	2.0%	1.0%	1.1%	1.1%
1.7%	3.2%	1.5%	1.2%	1.4%
1.5%	2.1%	0.4%	0.6%	0.0%
-0.2%	1.9%	0.6%	0.8%	0.7%
-0.5%	0.9%	0.5%	0.1%	1.4%
-0.8%	0.7%	0.2%	0.3%	-0.2%
0.7%	2.0%	0.7%	0.6%	0.6%
-0.2%	1.9%	0.6%	0.8%	0.7%
-0.7%	0.8%	0.4%	0.2%	0.6%
0.2%	1.7%	0.6%	0.5%	0.6%

Subjective Evaluation

ITRI's proposal reduce the wholes, but it could also artificially increase the patch sizes.



3D Geometry Padding (Sony)

Stronger gains for D2 metrics, but still some issues with luminance, specially for queen sequence.

All frames results

C2_ai — lossy geometry, lossy attributes [all intra]

		Geom. BD-TotGeomRate [%]		End-to-End BD-AttrRate [%]		
Class	Sequence	D1	D2	Luma	Chroma Cb	Chroma Cr
cat2-A	8ivfbv2_loot_vox10	4.9%	-0.1%	1.2%	1.8%	1.9%
	8ivfbv2_redandblack_vox10	4.1%	-0.8%	1.6%	3.2%	2.5%
	8ivfbv2_soldier_vox10	5.9%	0.6%	1.9%	3.0%	3.1%
	queen	8.3%	7.4%	16.0%	17.3%	12.7%
cat2-B	8ivfbv2_longdress_vox10	4.1%	-0.2%	0.1%	1.5%	1.6%
cat2-C	basketball_player_vox11	5.8%	0.4%	1.1%	1.4%	2.0%
	dancer_player_vox11	6.1%	0.0%	1.2%	1.8%	1.5%
Cat2-A average		5.8%	1.8%	5.2%	6.3%	5.1%
Cat2-B average		4.1%	-0.2%	0.1%	1.5%	1.6%
Cat2-C average		6.0%	0.2%	1.1%	1.6%	1.7%
Overall average		5.6%	1.0%	3.3%	4.3%	3.6%

C2_ra — lossy geometry, lossy attributes [inter, random access]

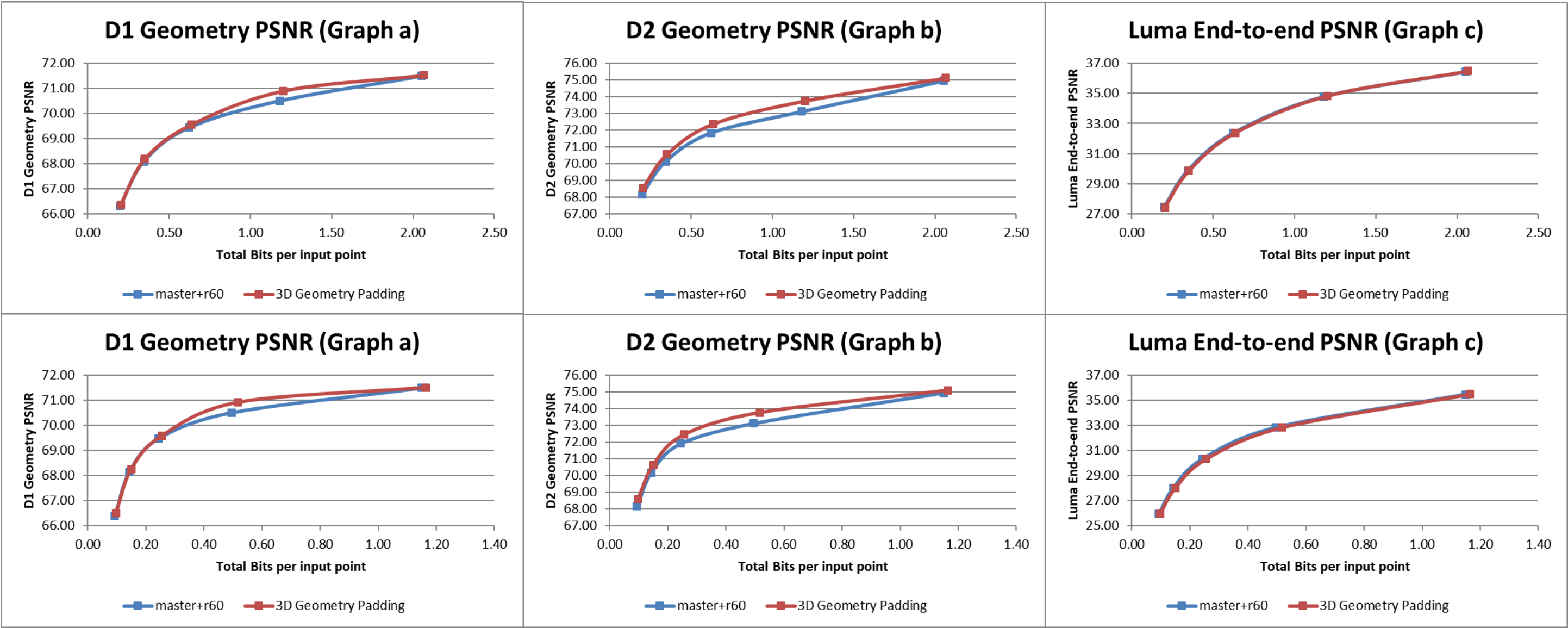
		Geom. BD-TotGeomRate [%]		End-to-End BD-AttrRate [%]		
Class	Sequence	D1	D2	Luma	Chroma Cb	Chroma Cr
cat2-A	8ivfbv2_loot_vox10	5.7%	0.6%	1.6%	1.9%	0.9%
	8ivfbv2_redandblack_vox10	4.8%	-0.2%	1.9%	3.0%	2.3%
	8ivfbv2_soldier_vox10	7.6%	2.5%	3.1%	4.0%	4.7%
	queen	11.6%	11.1%	21.1%	24.9%	18.6%
cat2-B	8ivfbv2_longdress_vox10	5.1%	0.5%	0.3%	1.8%	1.6%
cat2-C	basketball_player_vox11	6.2%	0.7%	1.2%	0.6%	2.7%
	dancer_player_vox11	6.5%	0.1%	1.3%	1.7%	1.8%
Cat2-A average		7.4%	3.5%	6.9%	8.4%	6.6%
Cat2-B average		5.1%	0.5%	0.3%	1.8%	1.6%
Cat2-C average		6.3%	0.4%	1.2%	1.1%	2.3%
Overall average		6.8%	2.2%	4.4%	5.4%	4.7%

Geom. BD-TotalRate [%]		End-to-End BD-TotalRate [%]		
D1	D2	Luma	Chroma Cb	Chroma Cr
-2.8%	-11.9%	4.6%	5.1%	5.2%
-3.9%	-12.3%	4.6%	5.9%	5.3%
-2.1%	-12.3%	4.5%	5.4%	5.5%
2.8%	-1.9%	15.7%	16.9%	12.9%
-5.6%	-14.7%	1.6%	2.8%	2.9%
-0.6%	-9.4%	4.5%	4.8%	5.3%
-0.7%	-10.7%	4.6%	5.1%	4.9%
-1.5%	-9.6%	7.3%	8.3%	7.2%
-5.6%	-14.7%	1.6%	2.8%	2.9%
-0.6%	-10.0%	4.5%	4.9%	5.1%
-1.8%	-10.4%	5.7%	6.6%	6.0%

Geom. BD-TotalRate [%]		End-to-End BD-TotalRate [%]		
D1	D2	Luma	Chroma Cb	Chroma Cr
-0.3%	-7.6%	9.2%	9.4%	8.8%
-1.9%	-9.3%	7.8%	8.5%	8.0%
-0.3%	-8.6%	10.0%	10.8%	11.2%
4.8%	1.1%	20.7%	24.1%	19.1%
-5.5%	-14.7%	4.0%	5.1%	5.0%
1.2%	-6.8%	6.5%	6.1%	7.5%
1.3%	-8.2%	6.4%	6.6%	6.7%
0.6%	-6.1%	11.9%	13.2%	11.8%
-5.5%	-14.7%	4.0%	5.1%	5.0%
1.3%	-7.5%	6.4%	6.3%	7.1%
-0.1%	-7.7%	9.2%	10.1%	9.5%

R&D Performance

Best case INTRA
(longdress)



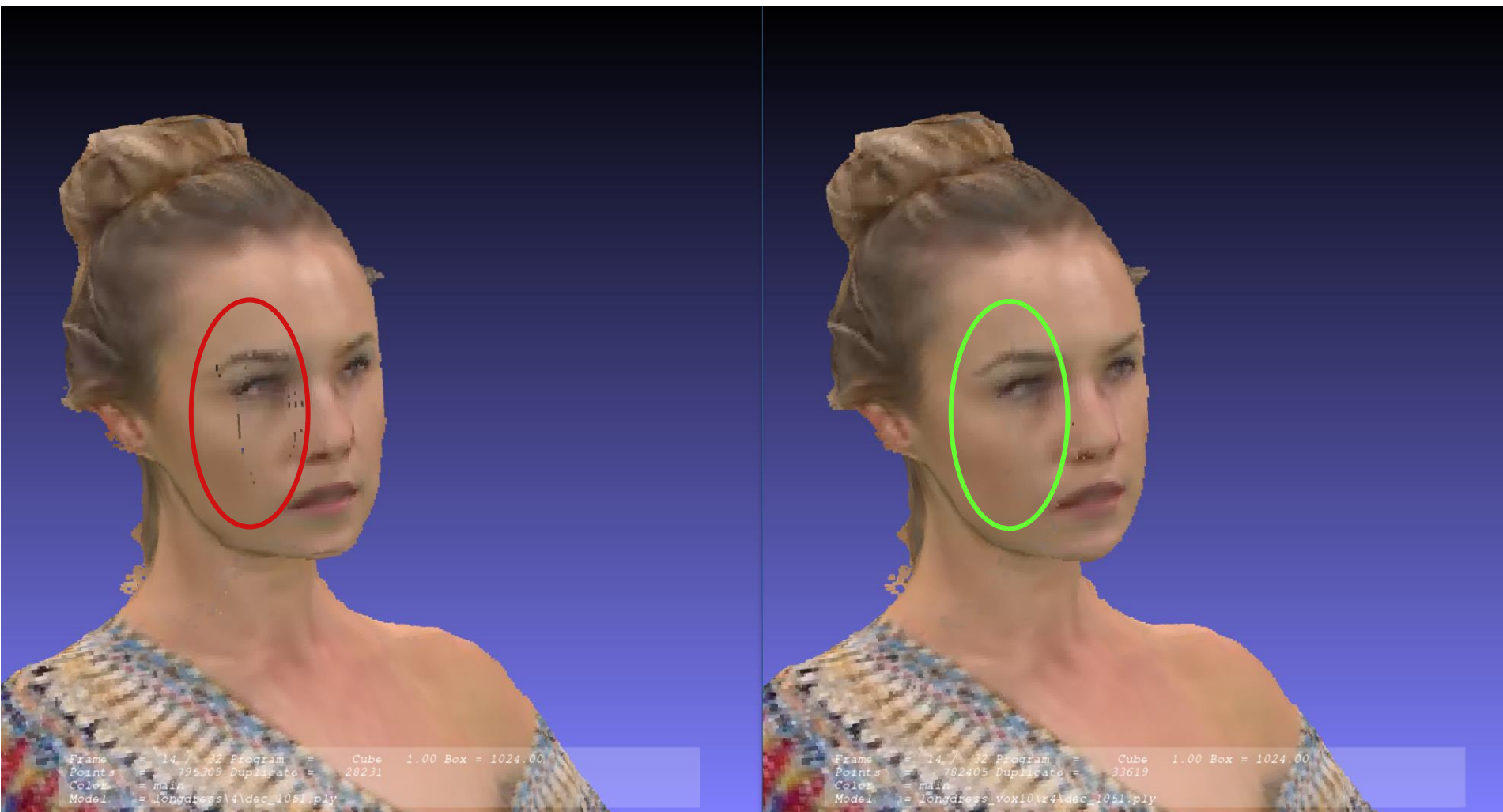
Best case INTER
(longdress)

The proposed technique uses more bits to encode background pixels, improving the quality of the geometry, but not of texture. Therefore, **D1 and D2 sees an improvement while Luma and Chrominance has slight decrease in RD performance.**

Subjective Analysis (longdress R4)



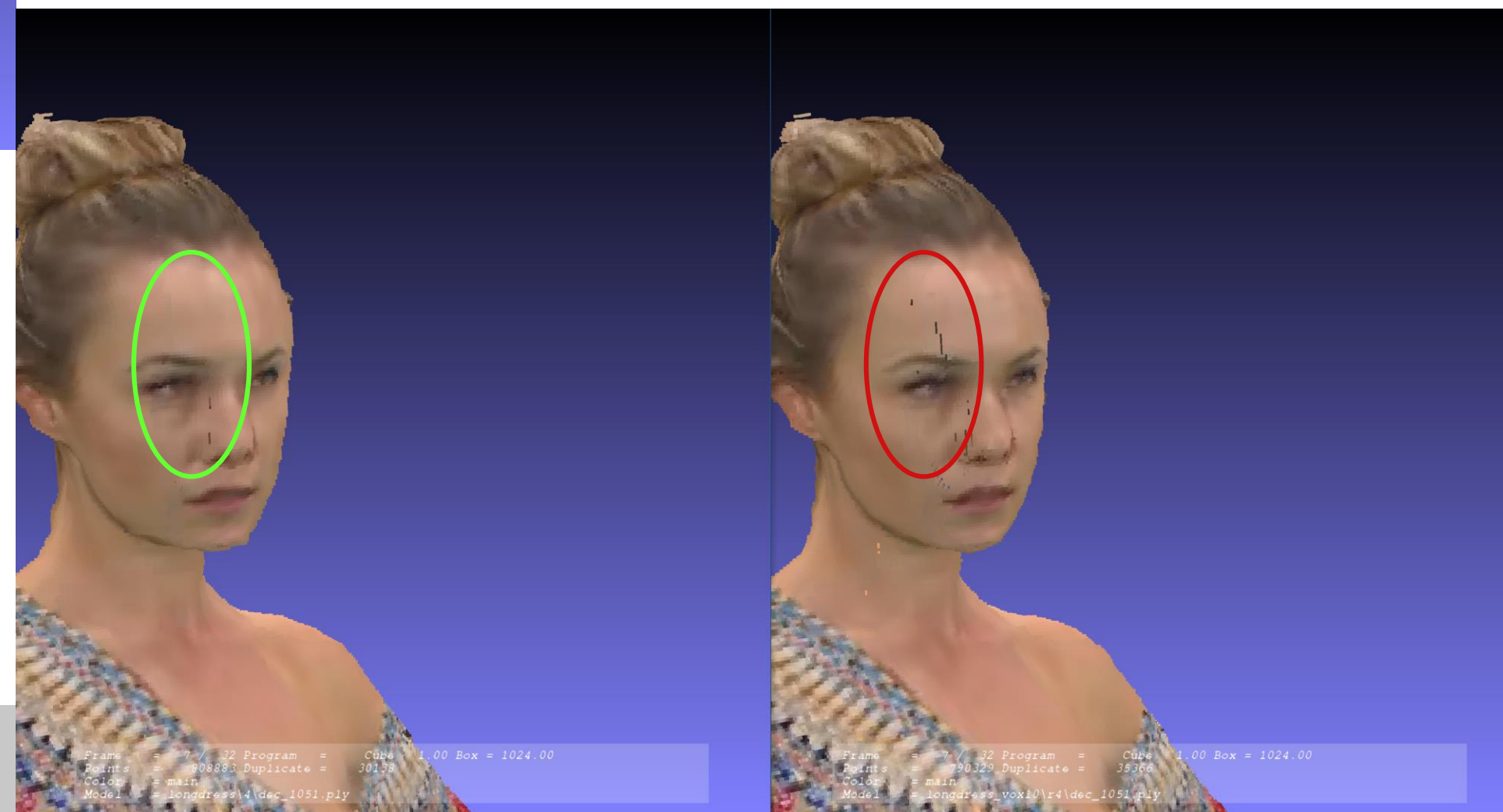
Subjective Analysis (longdress R4)



Different viewing angle shows holes

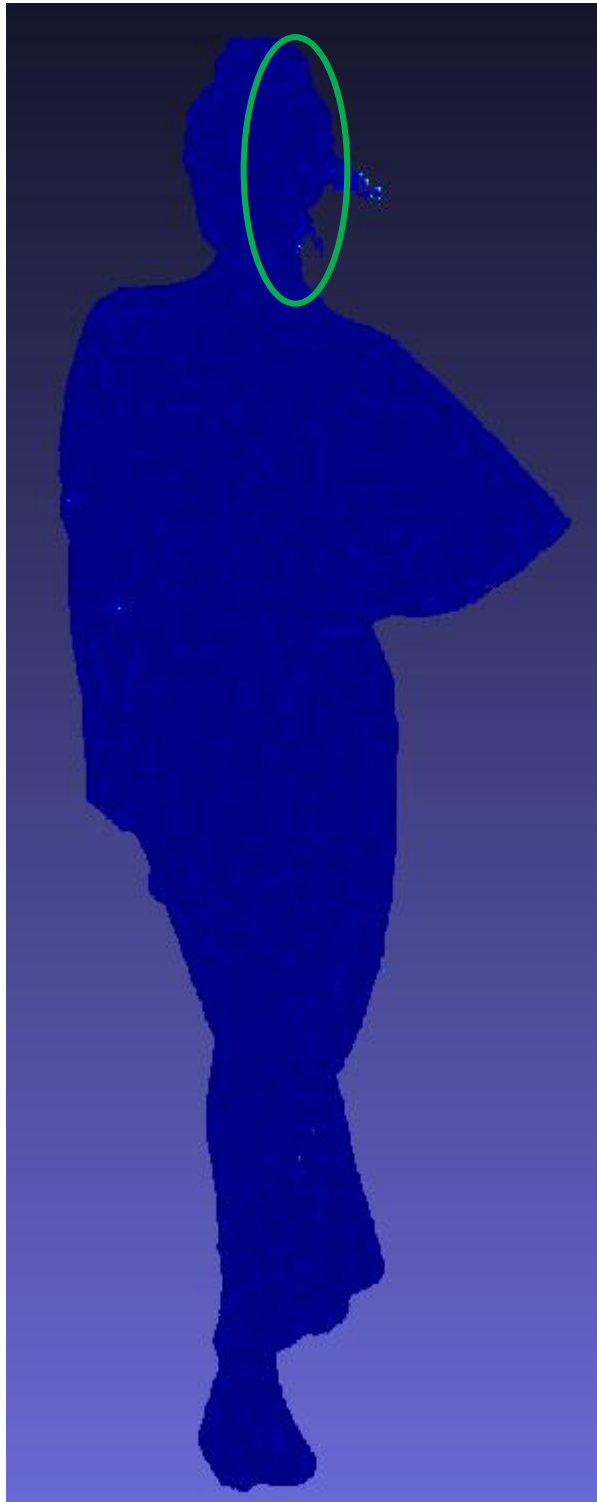
Holes possibly being caused by:

- 1) Projection loss
- 2) Patch Segmentation
- 3) Coding Artifact



Longdress AI R4 fr1501

With the new geometry padding, the distance between the reconstructed point cloud and the original point cloud is reduced, specially between the patches (see visible seams with anchor results)



Even though some holes are reduced, we can still see some artifacts, in the presence of smaller holes around her nostrils, which could be a result of a limitation of the projection

ITRI+SONY

D2 and Luma/Chrominance metrics are worst, but D1 metric is improved for both AI/RA conditions.

All frames results

C2_ai — lossy geometry, lossy attributes [all intra]

		Geom. BD-TotGeomRate [%]		End-to-End BD-AttrRate [%]		
Class	Sequence	D1	D2	Luma	Chroma Cb	Chroma Cr
cat2-A	8ivfbv2_loot_vox10	4.9%	2.4%	2.2%	2.7%	2.7%
	8ivfbv2_redandblack_vox10	3.7%	2.2%	2.8%	4.8%	3.9%
	8ivfbv2_soldier_vox10	5.3%	3.7%	3.5%	4.9%	5.0%
	queen	7.5%	9.9%	16.3%	17.4%	12.8%
cat2-B	8ivfbv2_longdress_vox10	3.7%	2.2%	1.1%	2.8%	2.8%
cat2-C	basketball_player_vox11	5.7%	2.0%	1.8%	2.3%	2.3%
	dancer_player_vox11	5.7%	1.4%	1.6%	2.3%	2.2%
Cat2-A average		5.4%	4.5%	6.2%	7.5%	6.1%
Cat2-B average		3.7%	2.2%	1.1%	2.8%	2.8%
Cat2-C average		5.7%	1.7%	1.7%	2.3%	2.3%
Overall average		5.2%	3.4%	4.2%	5.3%	4.5%

C2_ra — lossy geometry, lossy attributes [inter, random access]

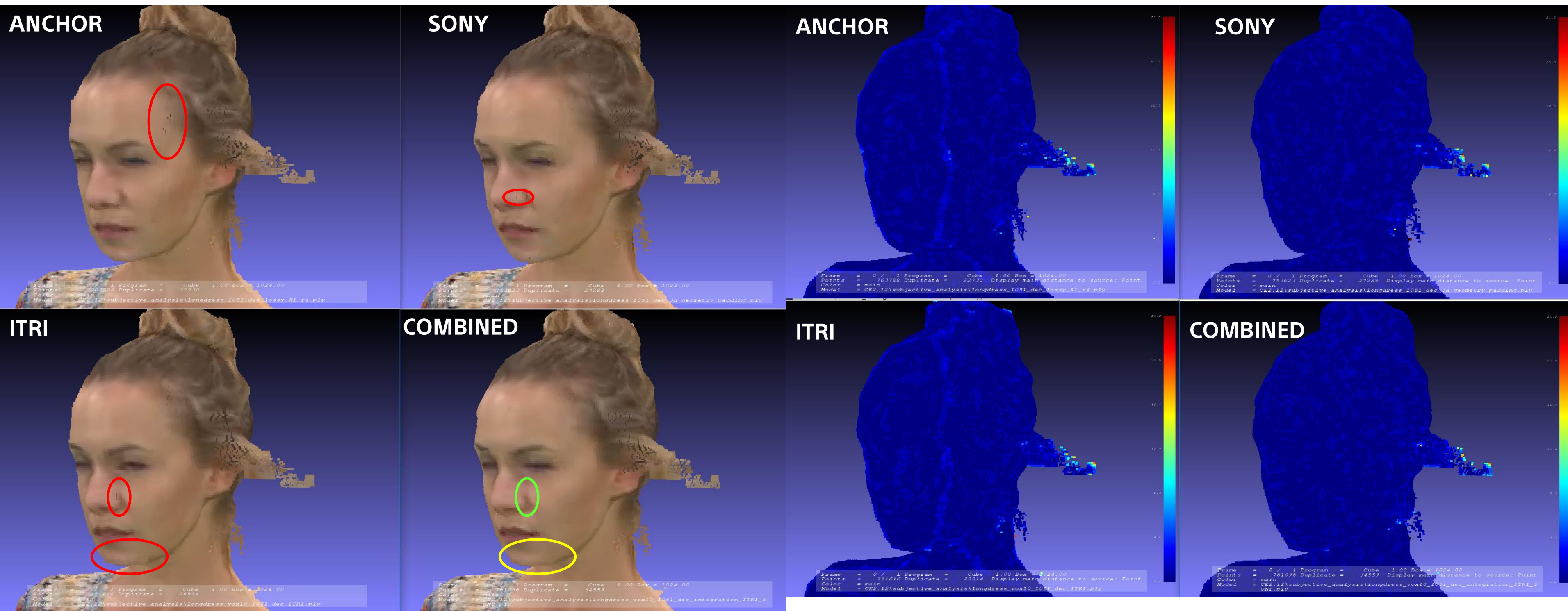
		Geom. BD-TotGeomRate [%]		End-to-End BD-AttrRate [%]		
Class	Sequence	D1	D2	Luma	Chroma Cb	Chroma Cr
cat2-A	8ivfbv2_loot_vox10	5.0%	2.7%	0.6%	0.4%	-0.6%
	8ivfbv2_redandblack_vox10	4.5%	2.9%	2.7%	3.6%	3.3%
	8ivfbv2_soldier_vox10	7.2%	6.2%	4.6%	5.0%	5.7%
	queen	9.5%	13.4%	21.2%	27.2%	18.8%
cat2-B	8ivfbv2_longdress_vox10	4.3%	2.7%	1.0%	2.5%	2.5%
cat2-C	basketball_player_vox11	5.6%	2.0%	1.8%	0.3%	2.6%
	dancer_player_vox11	6.1%	1.6%	1.2%	2.1%	0.9%
Cat2-A average		6.6%	6.3%	7.3%	9.1%	6.8%
Cat2-B average		4.3%	2.7%	1.0%	2.5%	2.5%
Cat2-C average		5.8%	1.8%	1.5%	1.2%	1.7%
Overall average		6.0%	4.5%	4.7%	5.9%	4.8%

Geom. BD-TotalRate [%]		End-to-End BD-TotalRate [%]		
D1	D2	Luma	Chroma Cb	Chroma Cr
-4.4%	-9.6%	5.9%	6.3%	6.3%
-5.7%	-9.3%	6.0%	7.8%	6.9%
-4.8%	-8.7%	6.2%	7.4%	7.4%
0.1%	0.6%	16.4%	17.5%	13.4%
-7.9%	-12.0%	2.6%	4.2%	4.2%
-1.7%	-7.9%	5.4%	5.8%	6.0%
-2.0%	-9.4%	5.1%	5.8%	5.7%
-3.7%	-6.8%	8.6%	9.7%	8.5%
-7.9%	-12.0%	2.6%	4.2%	4.2%
-1.9%	-8.6%	5.3%	5.8%	5.8%
-3.8%	-8.0%	6.8%	7.8%	7.1%

Geom. BD-TotalRate [%]		End-to-End BD-TotalRate [%]		
D1	D2	Luma	Chroma Cb	Chroma Cr
-2.4%	-5.9%	9.7%	9.8%	9.1%
-3.4%	-6.3%	9.3%	10.0%	9.6%
-2.5%	-4.8%	12.0%	12.7%	13.1%
0.9%	3.6%	21.3%	26.0%	19.7%
-8.6%	-12.3%	4.9%	6.1%	6.1%
-0.1%	-5.4%	7.2%	6.2%	7.9%
0.0%	-6.8%	6.9%	7.5%	6.7%
-1.8%	-3.3%	13.1%	14.6%	12.9%
-8.6%	-12.3%	4.9%	6.1%	6.1%
-0.1%	-6.1%	7.1%	6.8%	7.3%
-2.3%	-5.4%	10.2%	11.2%	10.3%

Subjective Analysis

Combined method seems to improve borders of patches, but enlarged patch problem still remains.



Conclusion

- ❖ ITRI's proposal shows improvement for hole filling, but may have issues with artificially enlarging the patch sizes. Nevertheless, the impact in R&D performance is small.
- ❖ Sony's proposal has a larger impact in R&D performance, since geometry background pixels are using more bits, and the effect of quality is only perceived for D2 metric, and not for the color components. Nevertheless, some holes are filled and the geometry metrics improve.
- ❖ The combined techniques improve D2 metrics, but still present artificially enlarged patch size.
- ❖ Both techniques are encoder only, and could be adopted in the test model software.