

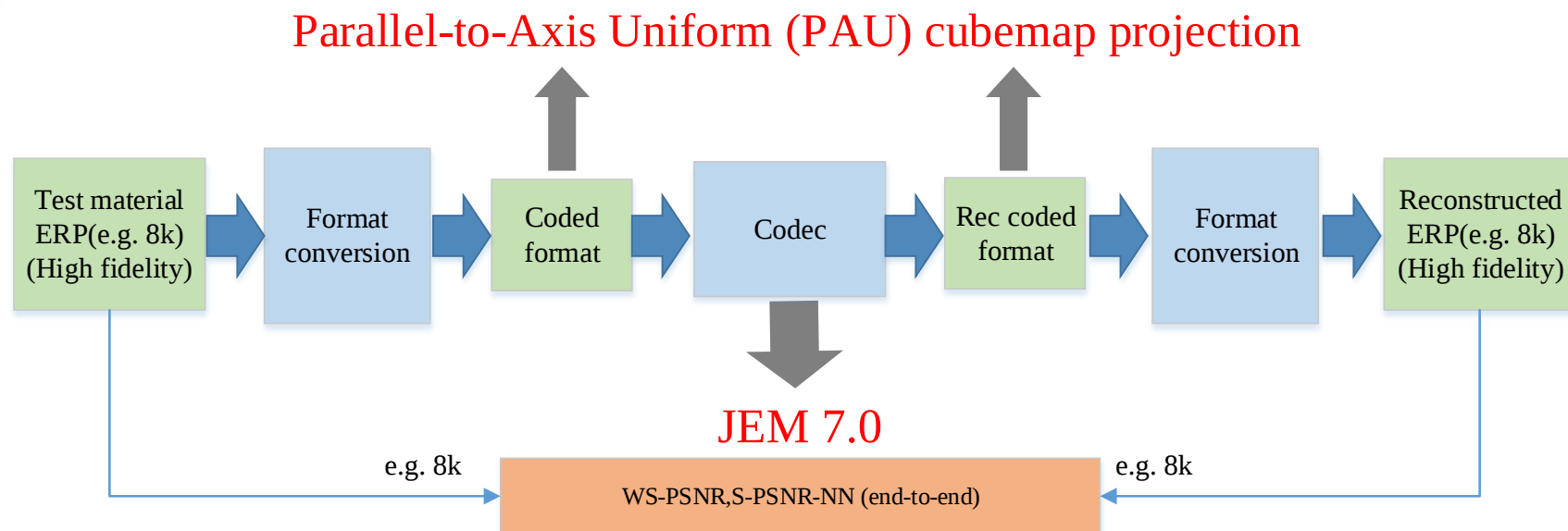
JVET-J0033

Description of 360 video coding technology proposal by Zhejiang University

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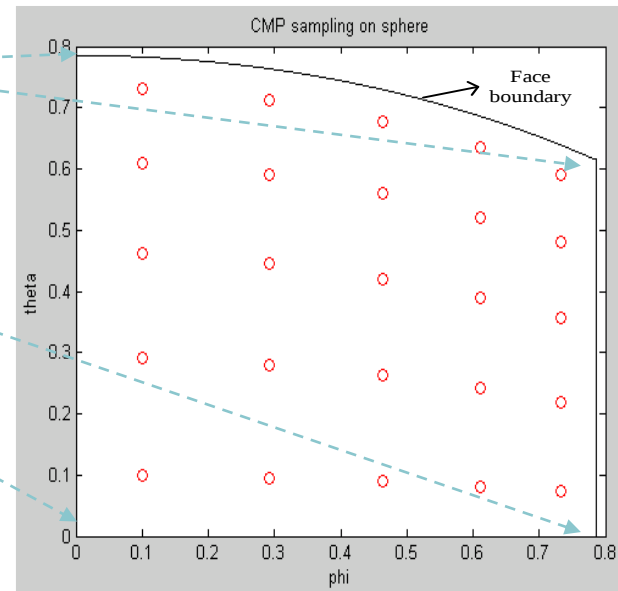
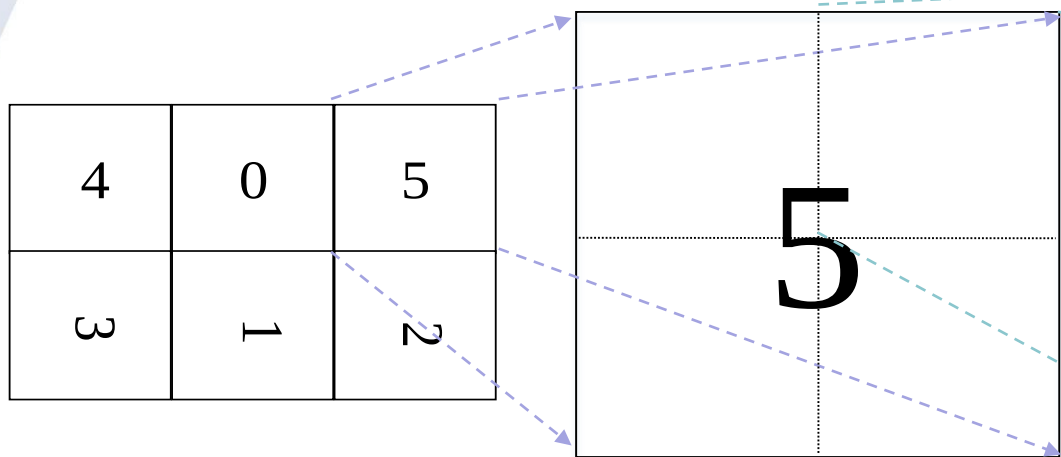
Introduction



Zhejiang University's response to CfP on 360 category

- Parallel-to-Axis Uniform (PAU) cubemap projection format with padding
- JEM 7.0 based, no specific 360 coding tools

Projection format - PAU

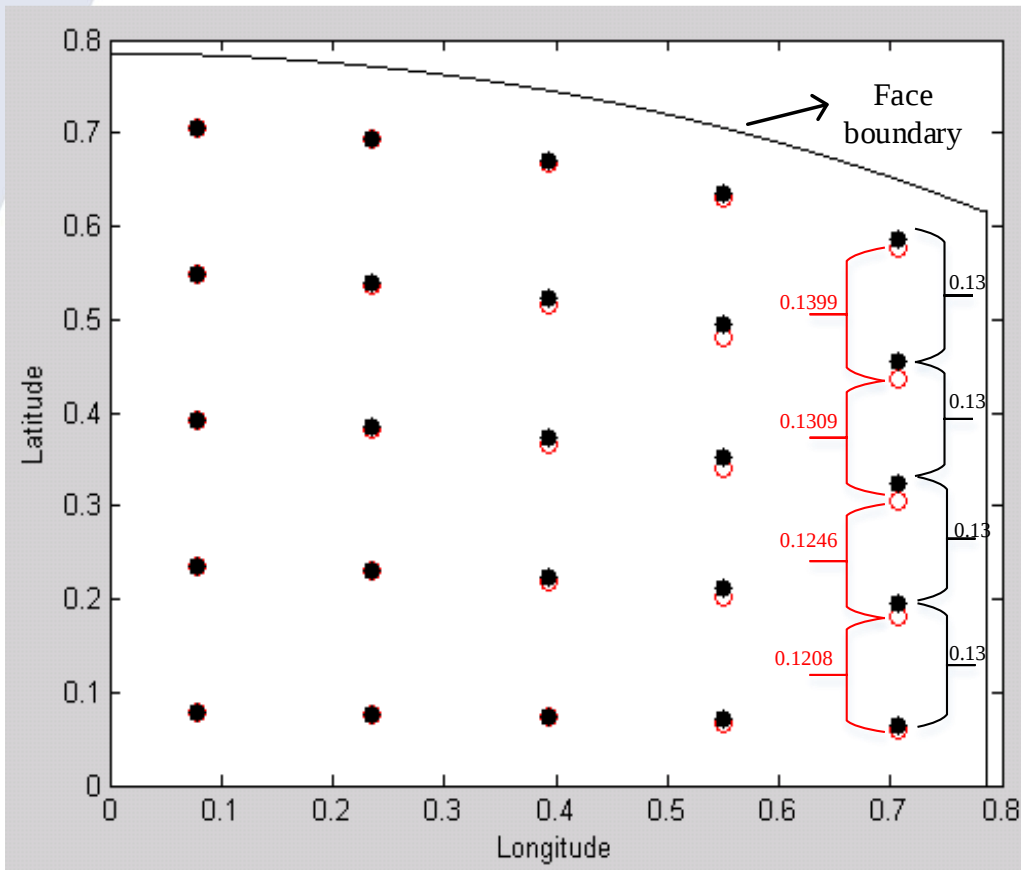


Sampling analysis of Cube map projection (CMP)

CMP: Sampling density near the face corner is higher than that of center.

- Uniform sampling distribution improves representation efficiency.
- 2D uniform mapping from sphere to a cube face is impossible.

Projection format - PAU



EAC (red point) and PAU (black point) sampling on spherical coordinate

Target to map as uniform as possible .

PAU

- Longitude direction:
 - equal angle (not equal length) between all pair of neighboring columns
- Latitude direction:
 - equal angle (equal length) for neighboring samplings on all column
 - the angle value for each column are different

Both directions: **P**arallel-to-**A**xis **U**niform

Projection format - PAU

The forward adjustment (map CMP to PAU):

$$v = \frac{4.0}{\pi} * \tan^{-1}(v') \quad (1)$$

$$\alpha = \tan^{-1}(v) \quad (2)$$

$$u = \frac{\tan^{-1}(u' * \cos(\alpha))}{\tan^{-1}(\cos(\alpha))} \quad (3)$$

The backward adjustment (map PAU to CMP):

$$v' = \tan\left(\frac{v\pi}{4.0}\right) \quad (4)$$

$$\beta = \tan^{-1}(v) \quad (5)$$

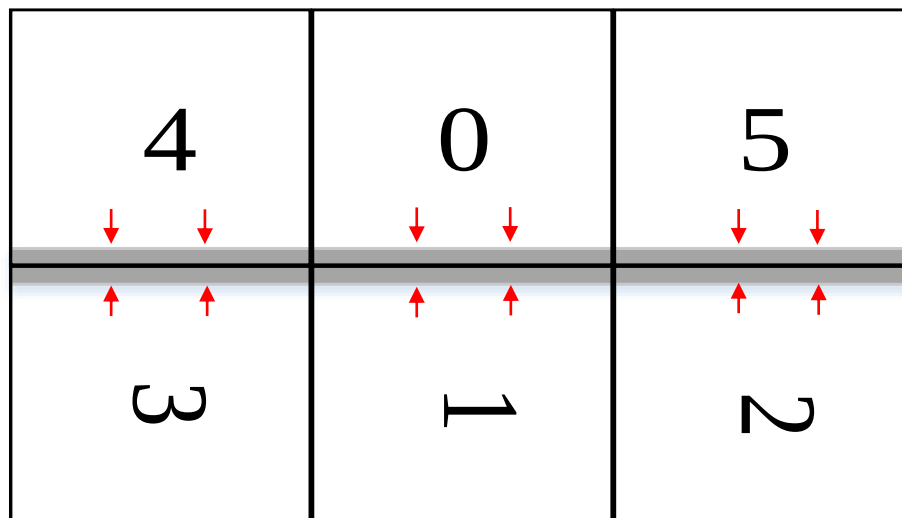
$$u' = \frac{1}{\cos(\beta)} * \tan(u * \tan^{-1}(\cos(\beta))) \quad (6)$$

Each face is defined in the range of $[-1, 1]$. (u', v') is defined in a CMP face, and (u, v) is the corresponding point in a PAU face.

Projection format - PAU

Padding

- ✓ Vertical face boundary
- ✓ Padding width: 3
- ✓ Padding value: copy



Compression performance

- Simulation setting
 - Based on 360Lib-5.0 and JEM 7.0
 - PAU (3*2 layout, Face width is 1184)
- Overall results

	Over HM16.16											
	E2E WS-PSNR			E2E SPSNR-NN			E2E WS-PSNR			E2E SPSNR-NN		
	BD-rate(Y)	BD-rate(U)	BD-rate(V)	BD-rate(Y)	BD-rate(U)	BD-rate(V)	BD-PSNR(Y)	BD-PSNR(U)	BD-PSNR(V)	BD-PSNR(Y)	BD-PSNR(U)	BD-PSNR(V)
Balboa	-39.5%	-47.0%	-51.4%	-39.5%	-47.1%	-51.4%	1.65	1.45	1.55	1.65	1.45	1.55
Chairlift	-43.9%	-56.8%	-52.9%	-43.8%	-56.8%	-52.8%	1.70	1.96	1.20	1.69	1.96	1.20
KiteFlite	-23.1%	-51.5%	-59.4%	-23.2%	-51.4%	-59.4%	1.03	1.86	1.95	1.03	1.86	1.96
Harbor	-25.9%	-52.1%	-52.6%	-25.7%	-52.1%	-52.7%	0.98	1.99	1.75	0.98	1.99	1.75
Trolley	-21.0%	-39.4%	-45.9%	-21.0%	-39.5%	-45.8%	1.00	1.66	1.74	1.00	1.67	1.74
Average 360	-30.7%	-49.4%	-52.4%	-30.6%	-49.4%	-52.4%	1.27	1.78	1.64	1.27	1.78	1.64
Enc Time[%]	508%											
Dec Time[%]	885%											

Compression performance

- Simulation setting
 - Based on 360Lib-5.0 and JEM 7.0
 - PAU (3*2 layout, Face width is 1184)
- Overall results

	Over JEM7.0											
	E2E WS-PSNR			E2E SPSNR-NN			E2E WS-PSNR			E2E SPSNR-NN		
	BD-rate(Y)	BD-rate(U)	BD-rate(V)	BD-rate(Y)	BD-rate(U)	BD-rate(V)	BD-PSNR(Y)	BD-PSNR(U)	BD-PSNR(V)	BD-PSNR(Y)	BD-PSNR(U)	BD-PSNR(V)
Balboa	-6.3%	-8.0%	-7.9%	-6.3%	-8.1%	-7.8%	0.20	0.12	0.11	0.20	0.12	0.11
Chairlift	-19.2%	-11.2%	-12.7%	-19.1%	-11.1%	-12.7%	0.63	0.21	0.17	0.63	0.20	0.17
KiteFlite	-6.8%	-7.3%	-15.3%	-6.7%	-7.2%	-15.2%	0.28	0.15	0.28	0.28	0.14	0.28
Harbor	-6.9%	-11.8%	-11.2%	-6.7%	-11.9%	-11.5%	0.24	0.24	0.19	0.24	0.24	0.19
Trolley	-6.0%	-5.9%	-12.4%	-5.9%	-5.9%	-12.4%	0.27	0.15	0.27	0.27	0.15	0.27
Average 360	-9.0%	-8.8%	-11.9%	-9.0%	-8.8%	-11.9%	0.32	0.17	0.20	0.32	0.17	0.20

Conclusion

- Parallel-to-axis uniform (PAU) cube map projection is proposed
 - 30.7% and 9.0% average bit rate saving (E2E WS-PSNR) achieved compared with HM and JEM anchor with PERP
- Recommendations
 - Evaluate PAU projection format based on potential test model

Thank you for your attention!