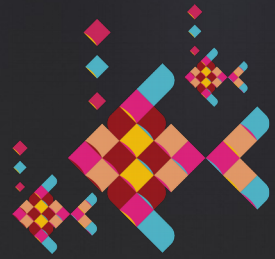
STANFORD
COMPUTATIONAL
IMAGING



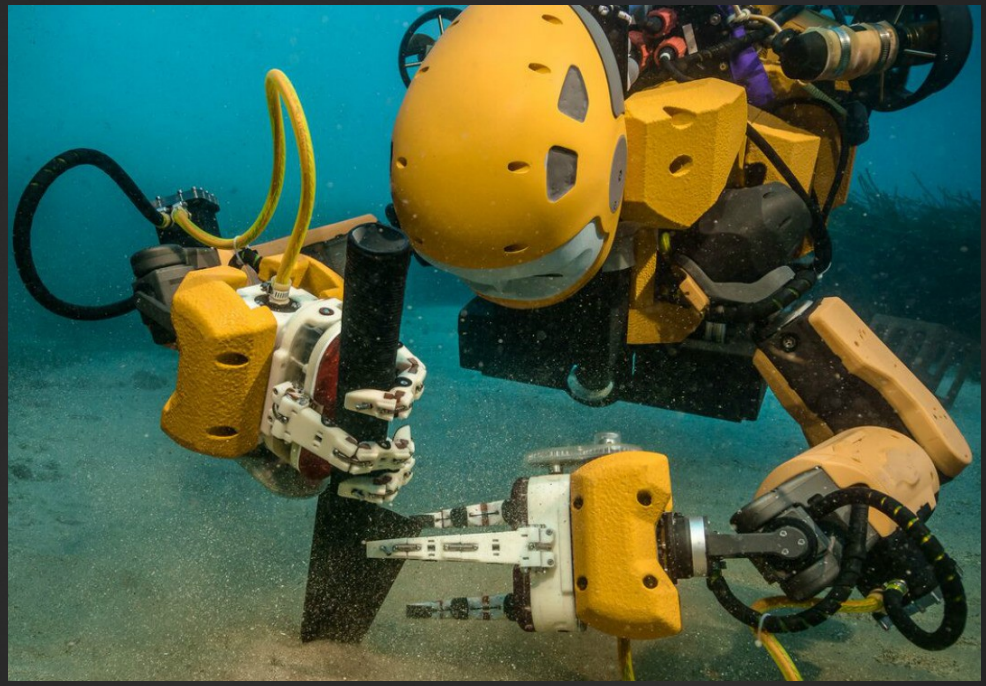
SpinVR: Towards Live-Streaming 3D Virtual Reality Video

Robert Konrad*, Donald G. Dansereau*,
Aniq Masood, Gordon Wetzstein

SIGGRAPH ASIA
29 Nov 2017

Live-Streaming VR

Live-Streaming VR

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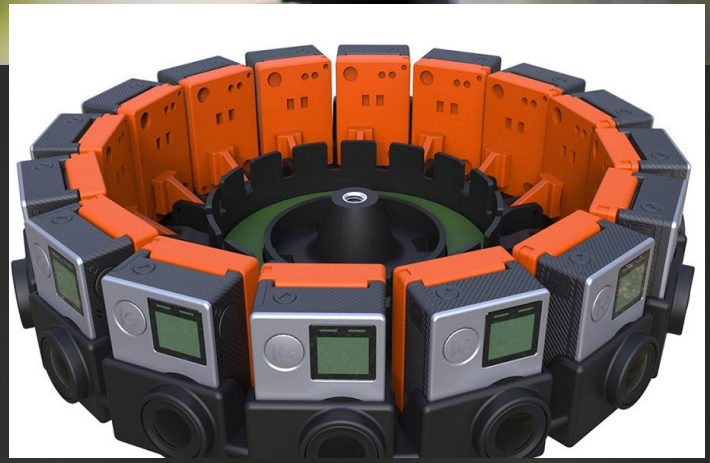
VR Cameras


facebook
SURROUND360
facebook
SURROUND360


YI
YI
YI
YI
YI
YI HALO



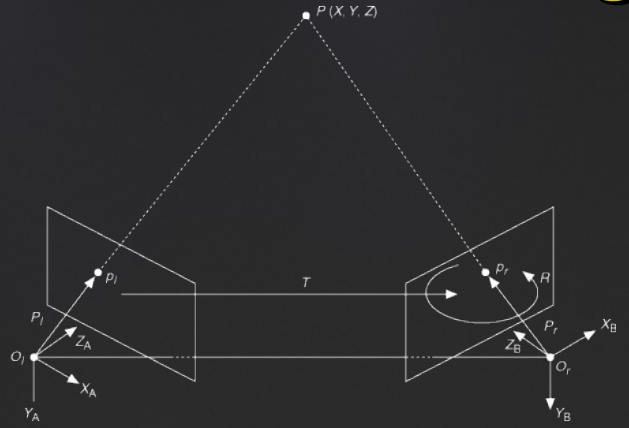
Computational Burden

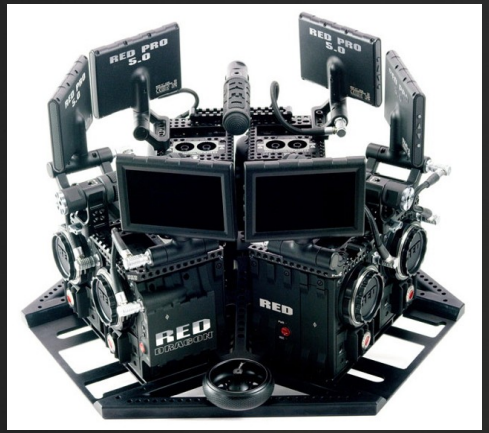
Raw Data: 10's of Gb/sec

Compute time: 10's of seconds / frame
in data center

Live-Streaming VR Cameras

Calibration





Artefacts

Transparency, reflections

Occlusions, flow mismatches

[Anderson2016]

Artefacts

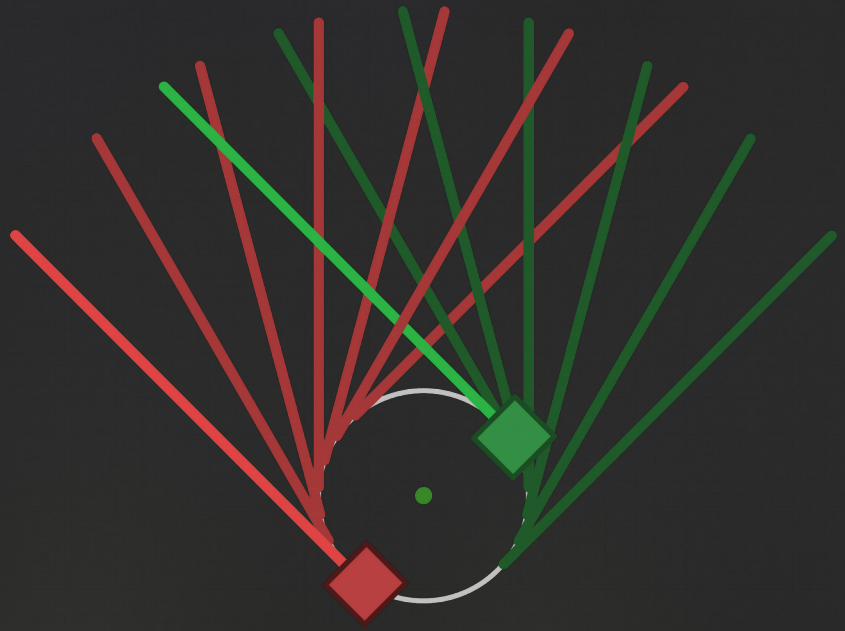
Fine structures

Too close

[Anderson2016]

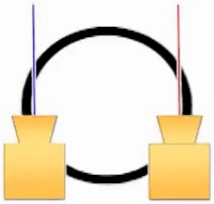
SpinVR

Omnidirectional Stereo Video



[Peleg 2001, Richardt2013]

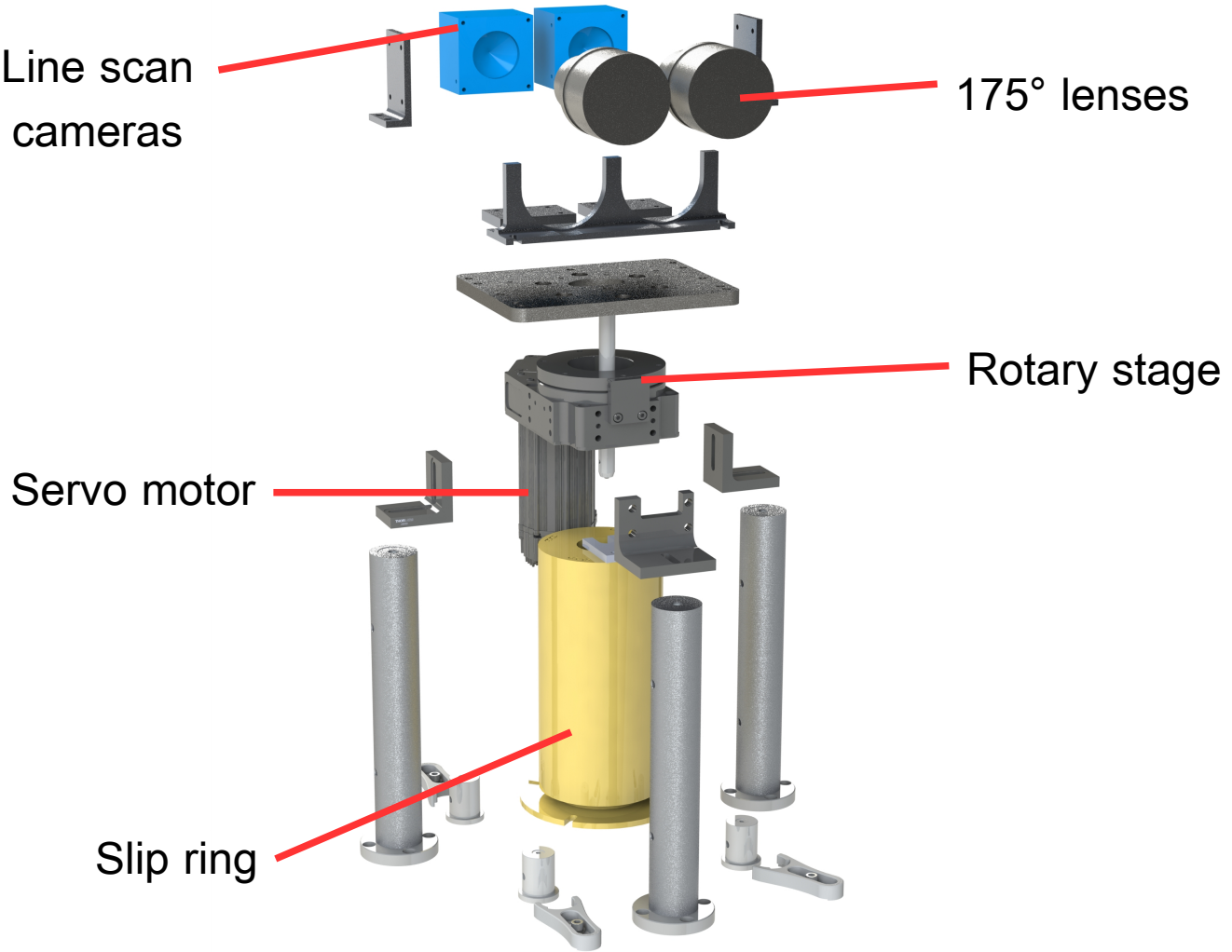
Omnidirectional Stereo



Left Eye

Right Eye

widely used by YouTube VR, Google Daydream, Facebook, ...


Line scan cameras
175° lenses
Rotary stage
Servo motor
Slip ring

Pipeline Comparison

Minimal capture BW

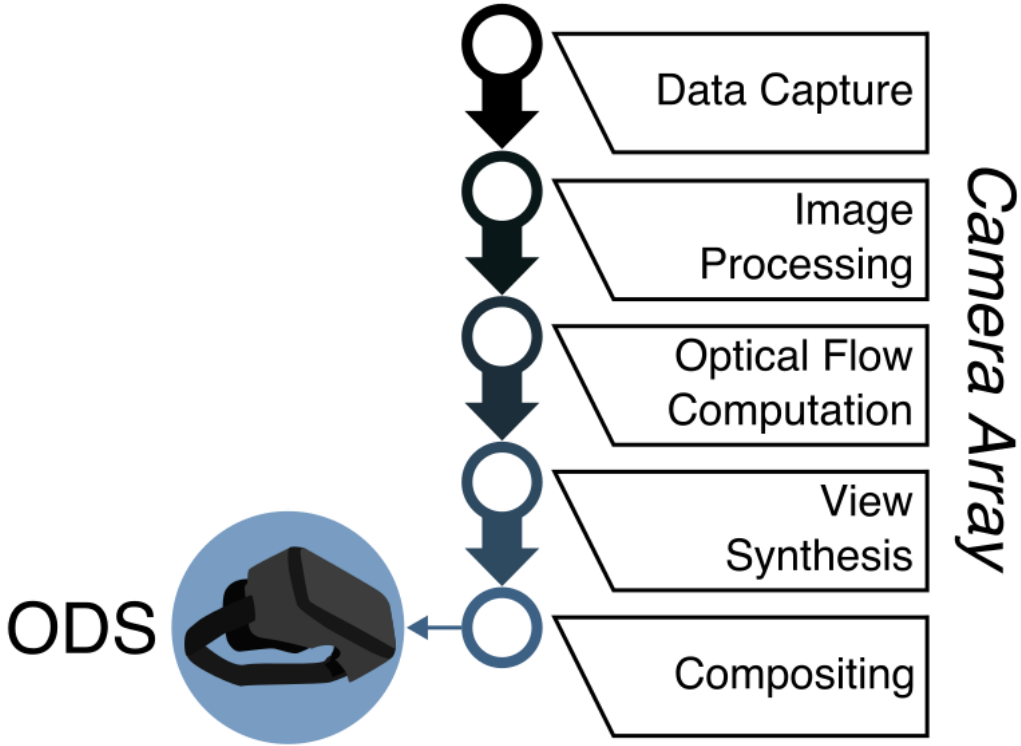
Minimal compute

→ Solves artefact issues*

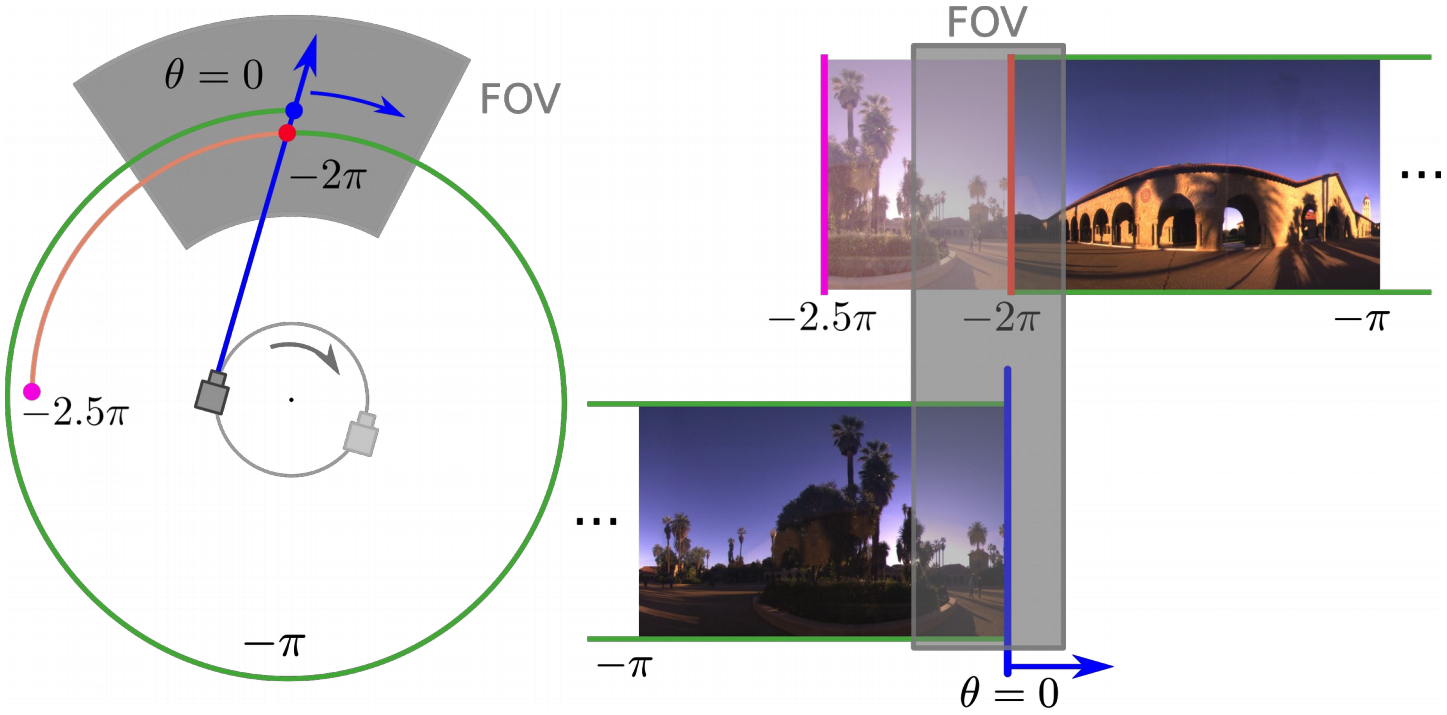
→ No calibration*

*Some new challenges

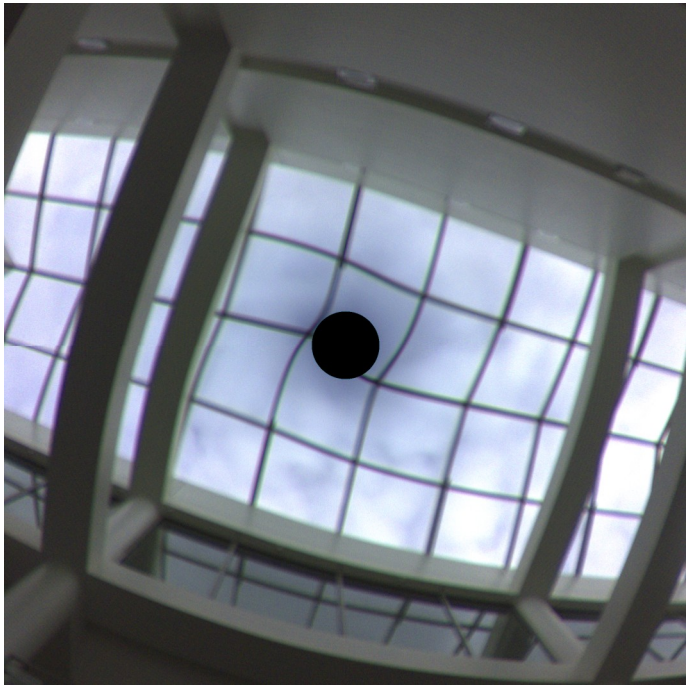
*New design space

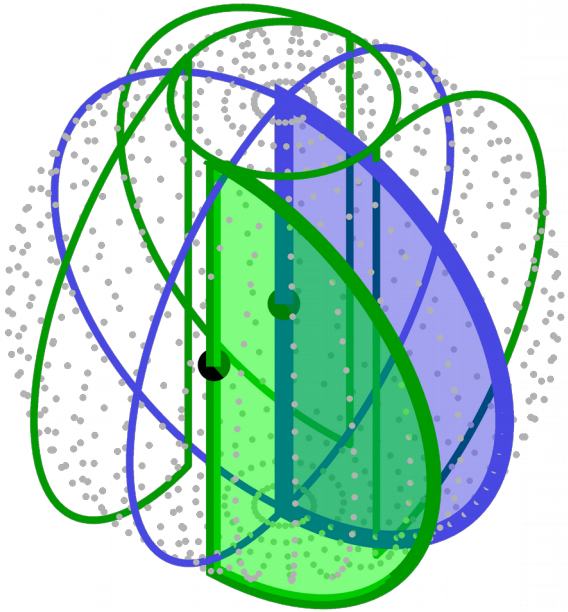


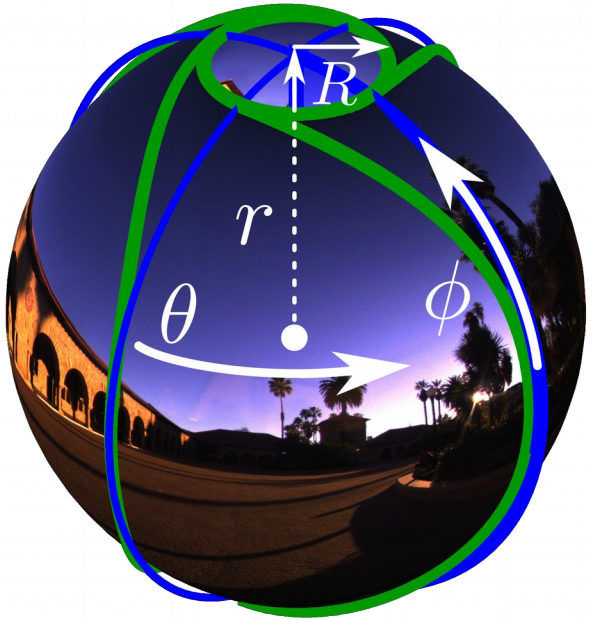
1) Seamless Rendering



2) Warping at the Poles



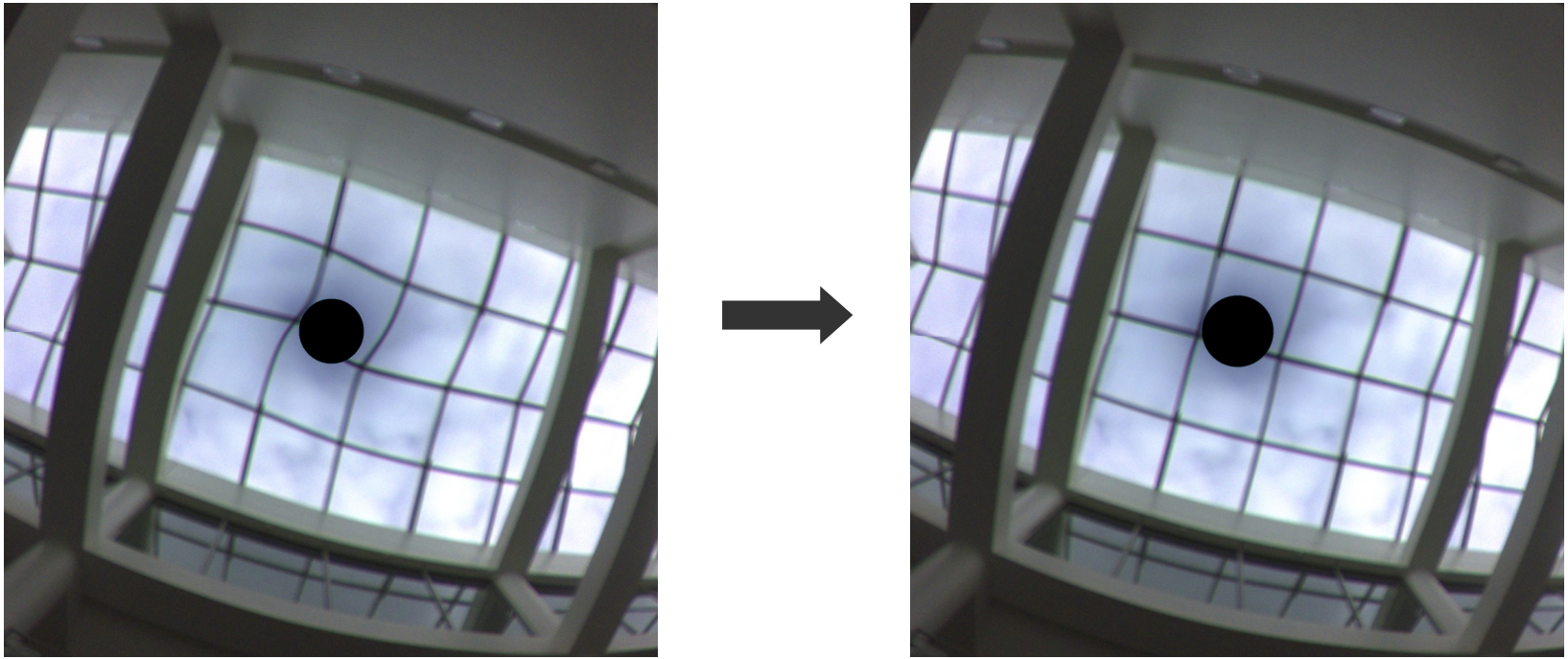




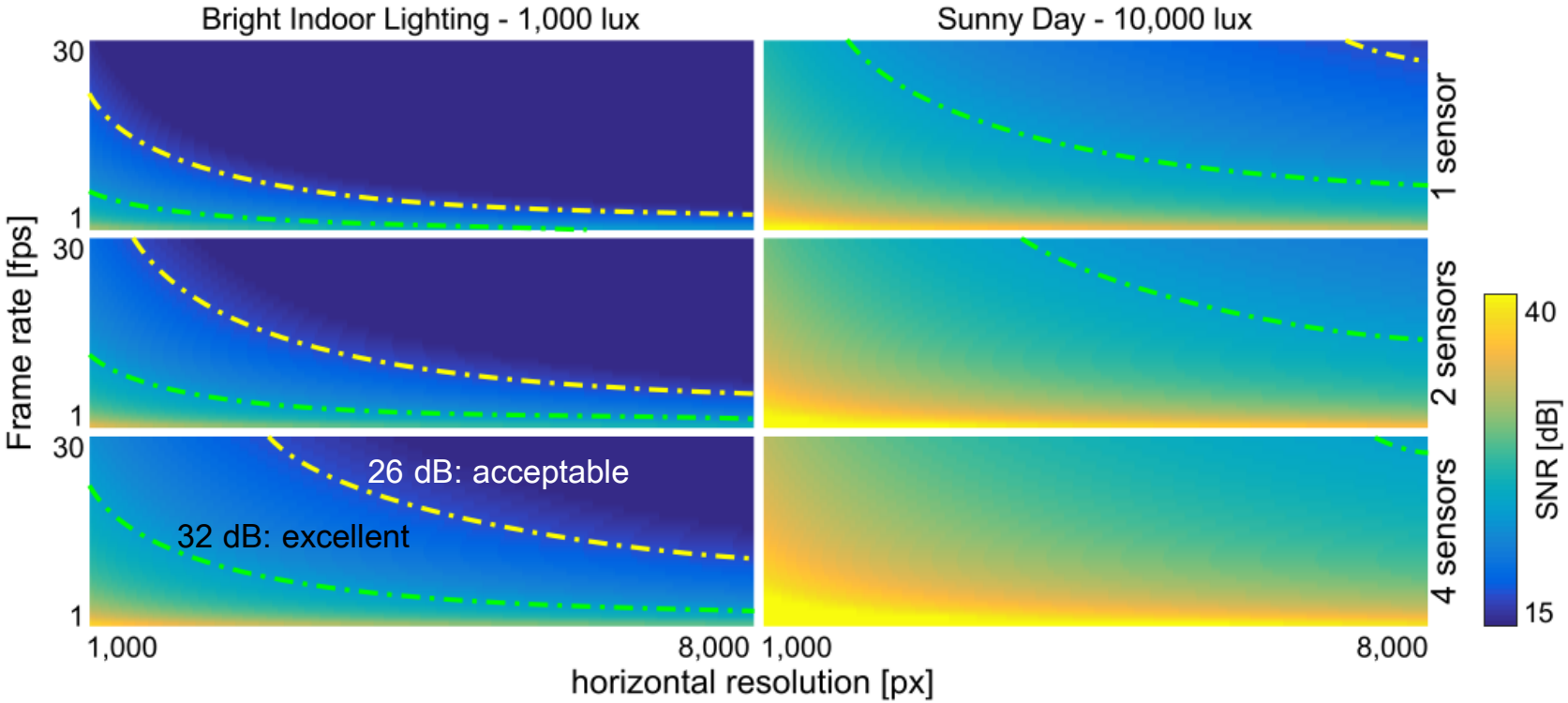
$$\Delta\theta = \tan^{-1}\left(\frac{R/r}{\cos\phi}\right)$$

$$\Delta\phi = \tan^{-1}\left(\frac{\sin\phi}{\sqrt{(R/r)^2 + \cos^2\phi}}\right) - \phi$$

2) Warping at the Poles



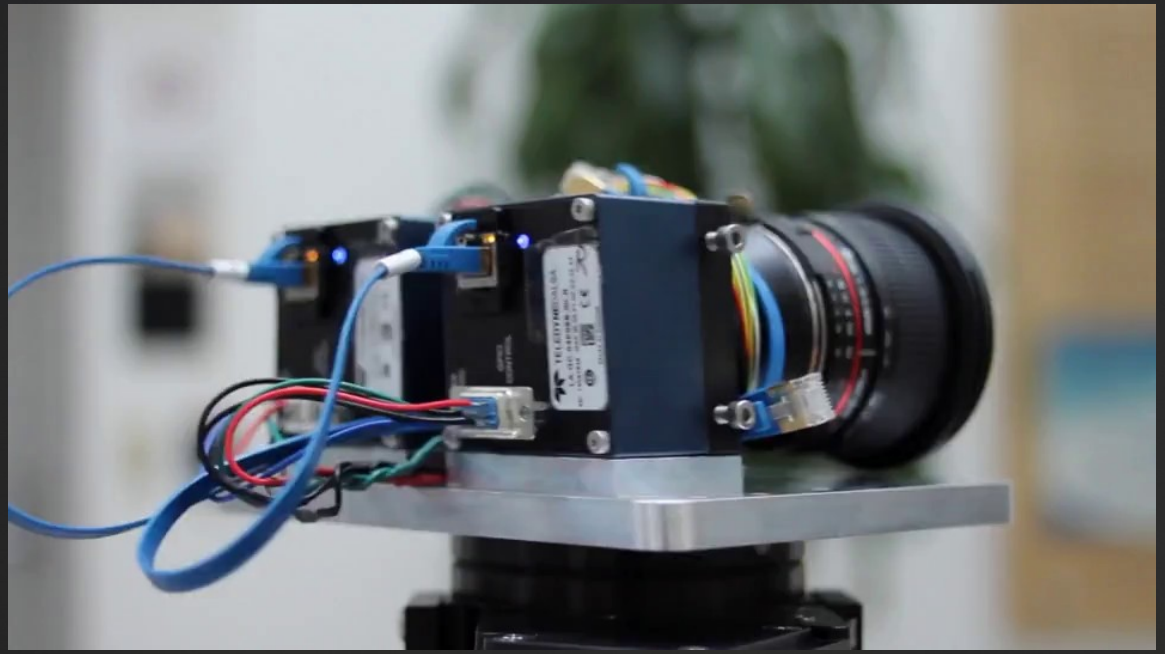
3) Design Tradeoffs



Outdoor: 1 sensor per eye allows exellent quality

Indoor: More sensors / tradeoffs are needed

Prototype




Live Streaming

SNR Validation

8192 x 4096 x 1/26 fps

4096 x 4096 x 1.11 fps

2048 x 4096 x 16.67 fps

SNR Validation

8192 x 4096 x 1/26 fps

4096 x 4096 x 1.11 fps

2048 x 4096 x 16.67 fps


Fountain15 fullres injected
https://goo.gl/hzhU9e
0:00 / 0:17

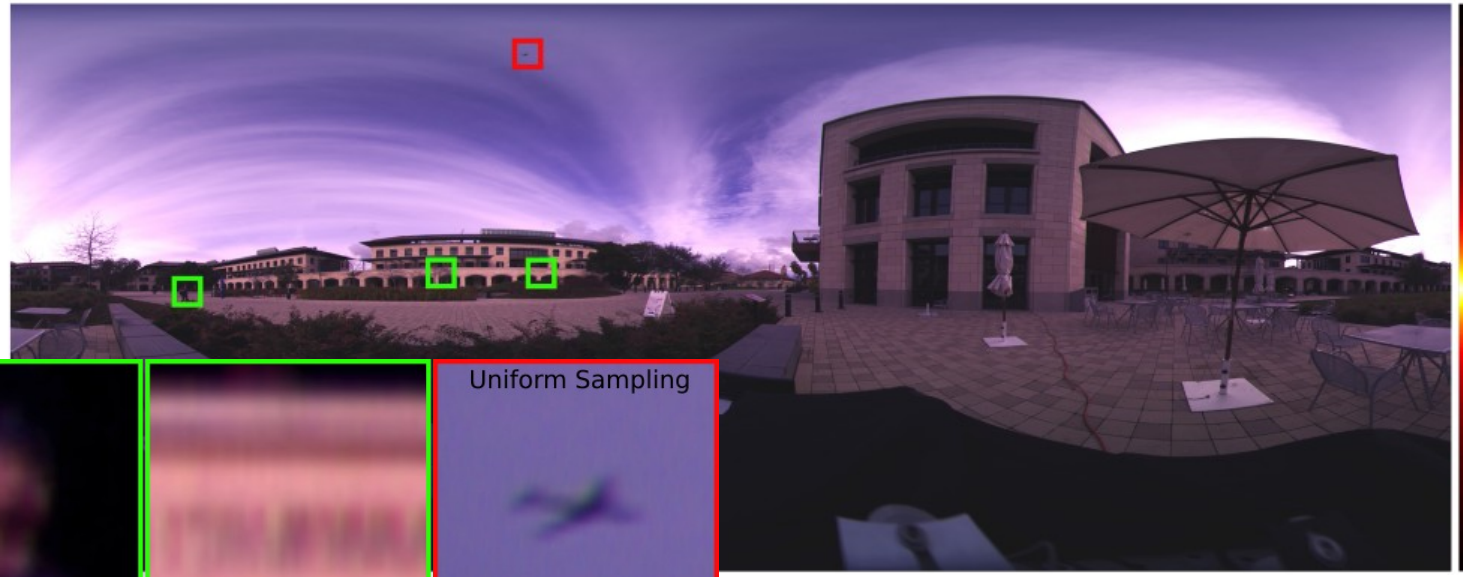
Challenging Scenes

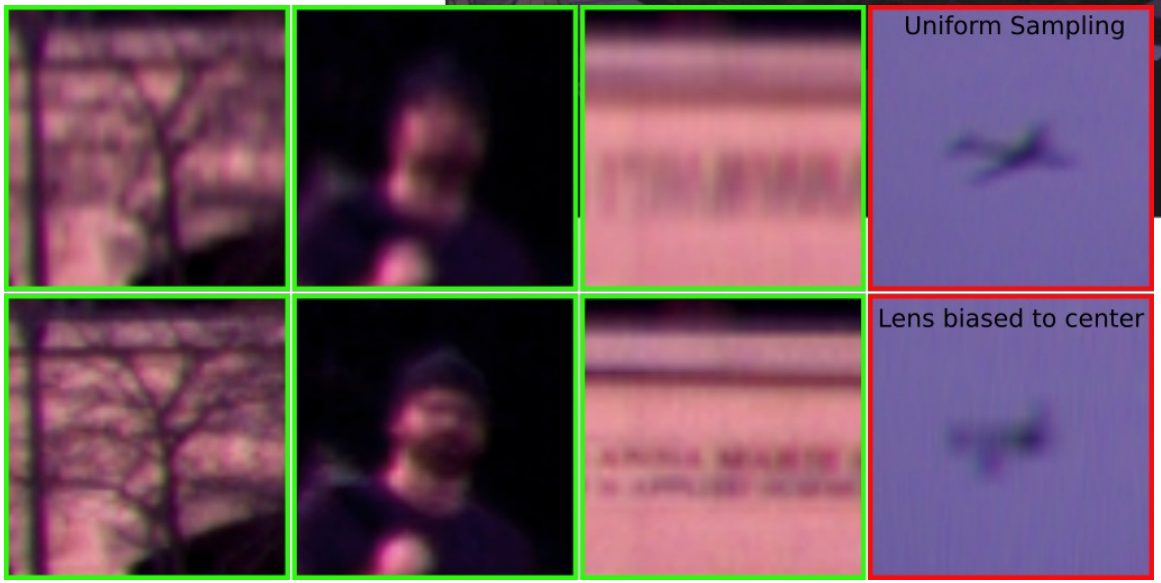
Too close

Challenging Scenes

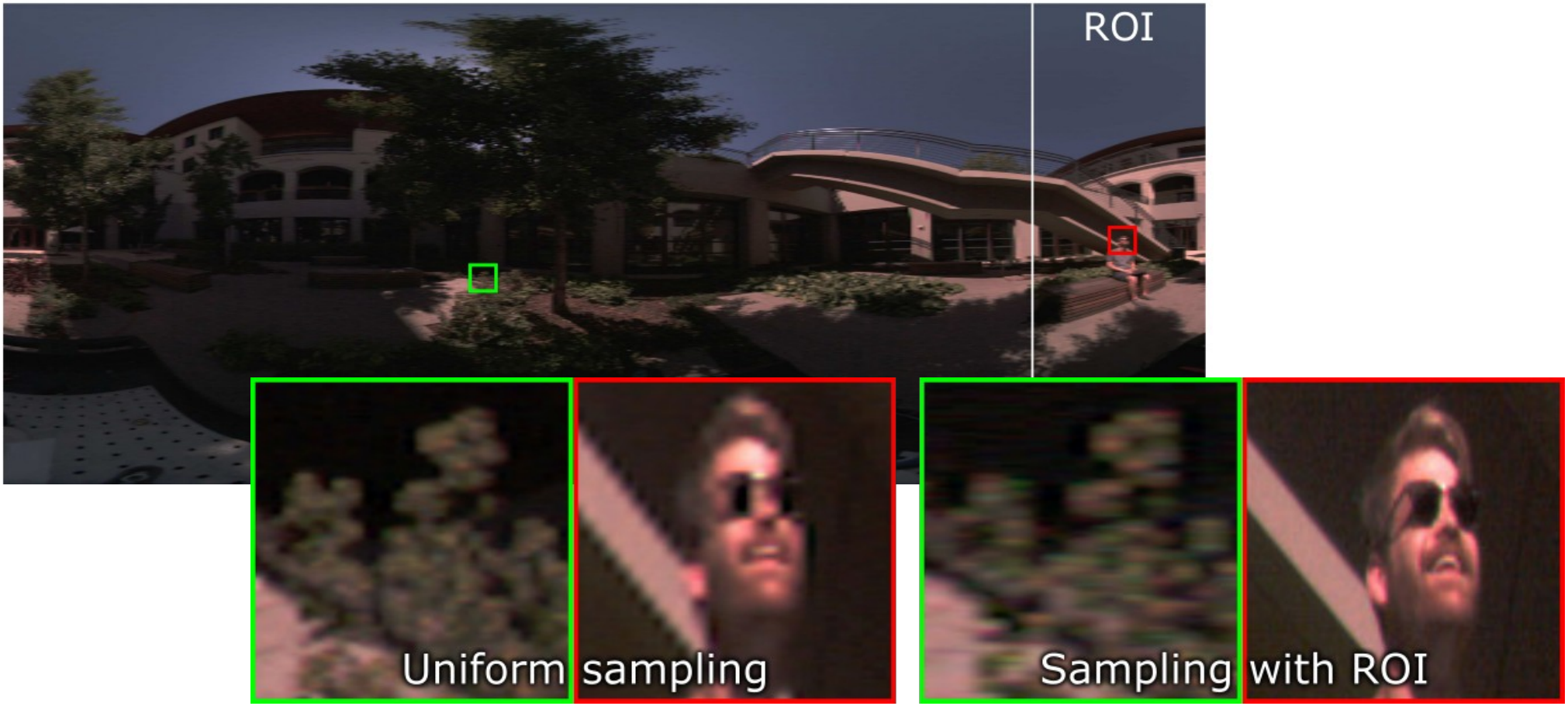
- Reflections
- Transparency
- Occlusions
- Fine structure

Vertical Nonuniform Sampling





Horizontal Nonuniform Sampling



Future Directions

Smaller & more cameras

Optical offlink

→ Higher FPS

Alternative optics

[aggarwal2016]

Conclusions

Streaming VR

Low computational cost

Resillient to common artefacts

Dewarping at poles

Perceptual saliency

SNR analysis

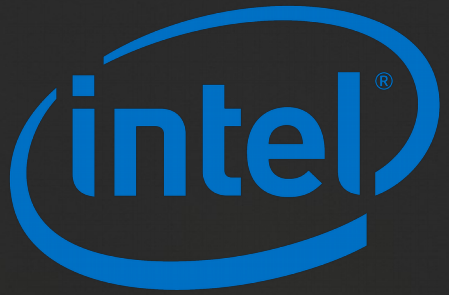
Acknowledgments

Ian McDowall

Surya Singh

Brian Cabral

Steve Mann




ComputationalImaging.org
dgd.vision