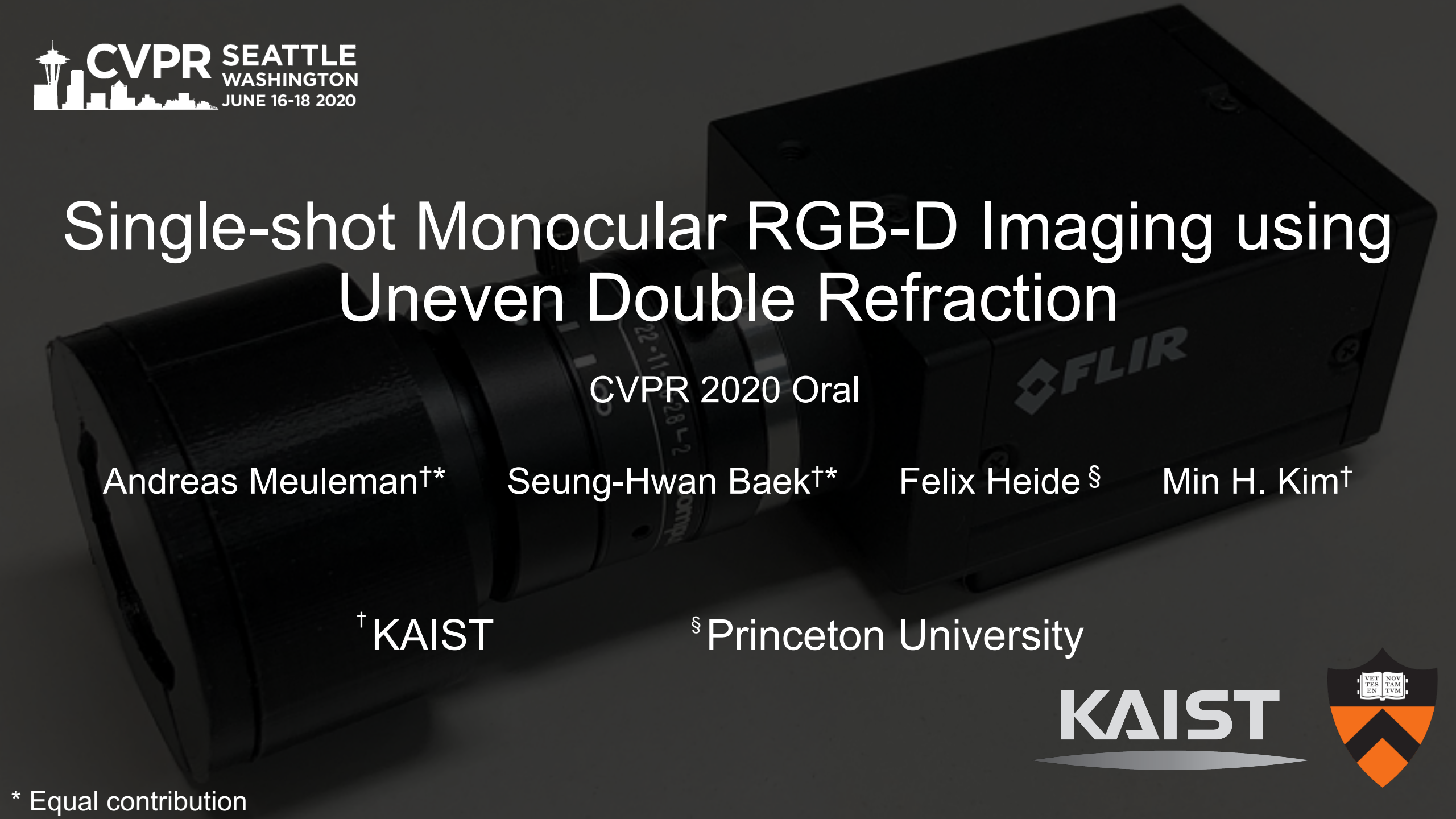


CVPR SEATTLE WASHINGTON JUNE 16-18 2020

Single-shot Monocular RGB-D Imaging using Uneven Double Refraction

CVPR 2020 Oral

Andreas Meuleman[†*] Seung-Hwan Baek[†*] Felix Heide[§] Min H. Kim[†]

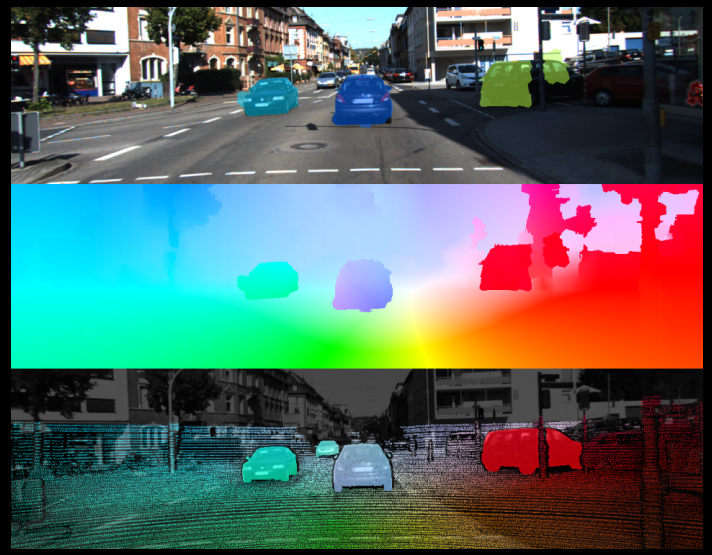
[†] KAIST [§] Princeton University

KAIST

* Equal contribution

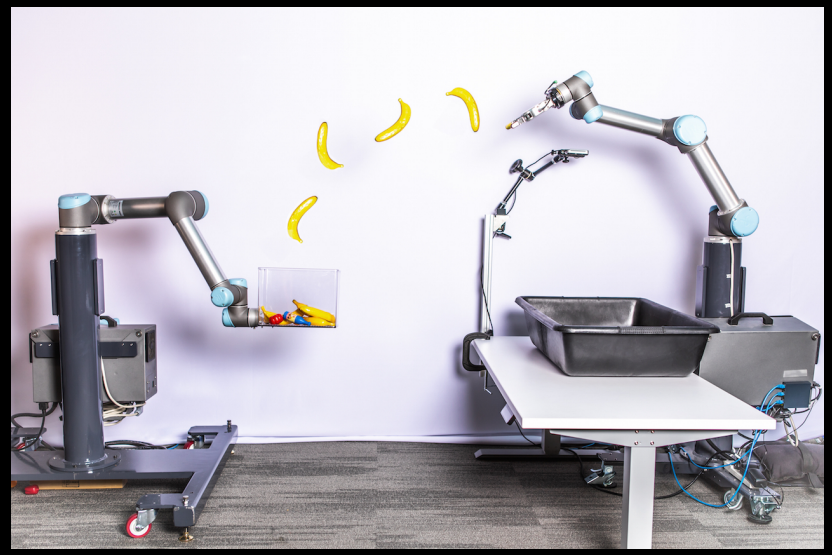
RGB-D Imaging Applications

Autonomous vehicles



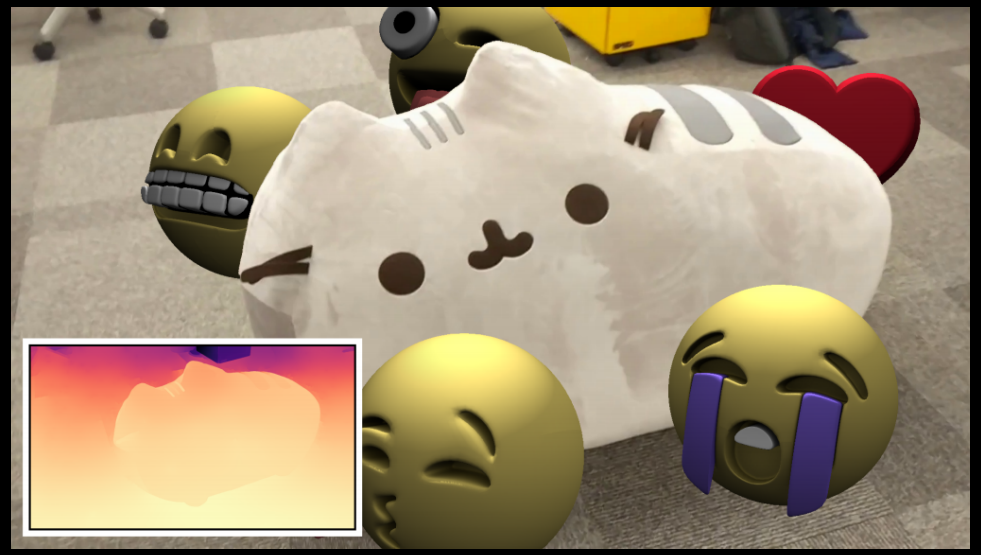
[Menze and Geiger CVPR15]

Robotics



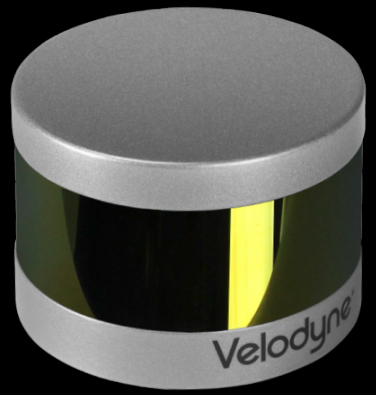
[Zeng et al. RSS19]

VR/AR



[Holynski and Kopf TOG18]

RGB-D Cameras



Velodyne

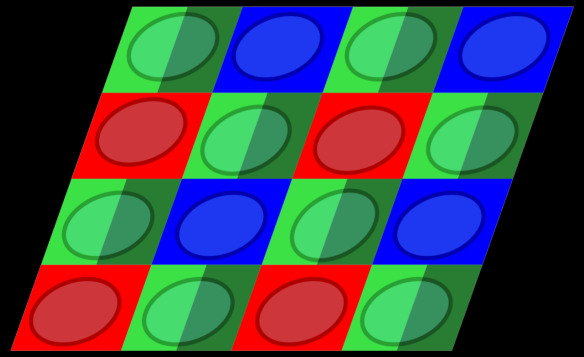
Pulsed ToF
- High cost
- Sparse sampling

Microsoft

Correlation ToF
- Indoor only
- Occlusion issue

Apple

Multi-view camera
- Occlusion issue
- Large form factor
- Synchronization



[Garg et al., ICCV19]

Dual pixel
- Short depth range

Lytro

Light-field camera
- Low spatial resolution

Goals of Our Monocular RGB-D Imaging

Passive

- Indoor/outdoor

Creative commons

Single shot

- Dynamic scene

Creative commons

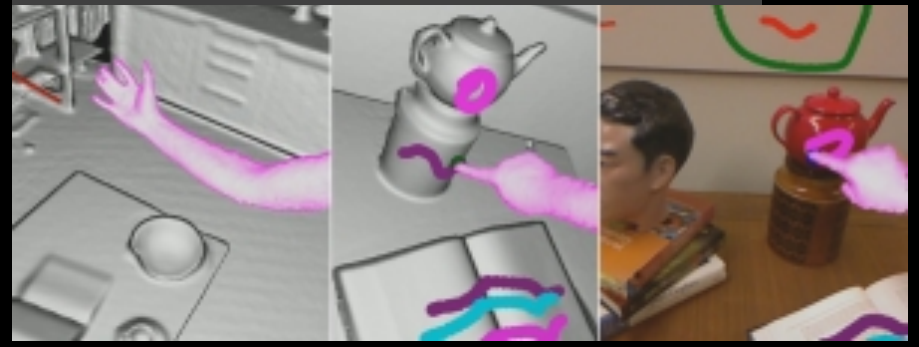
Single camera

- Small form factor

FLIR

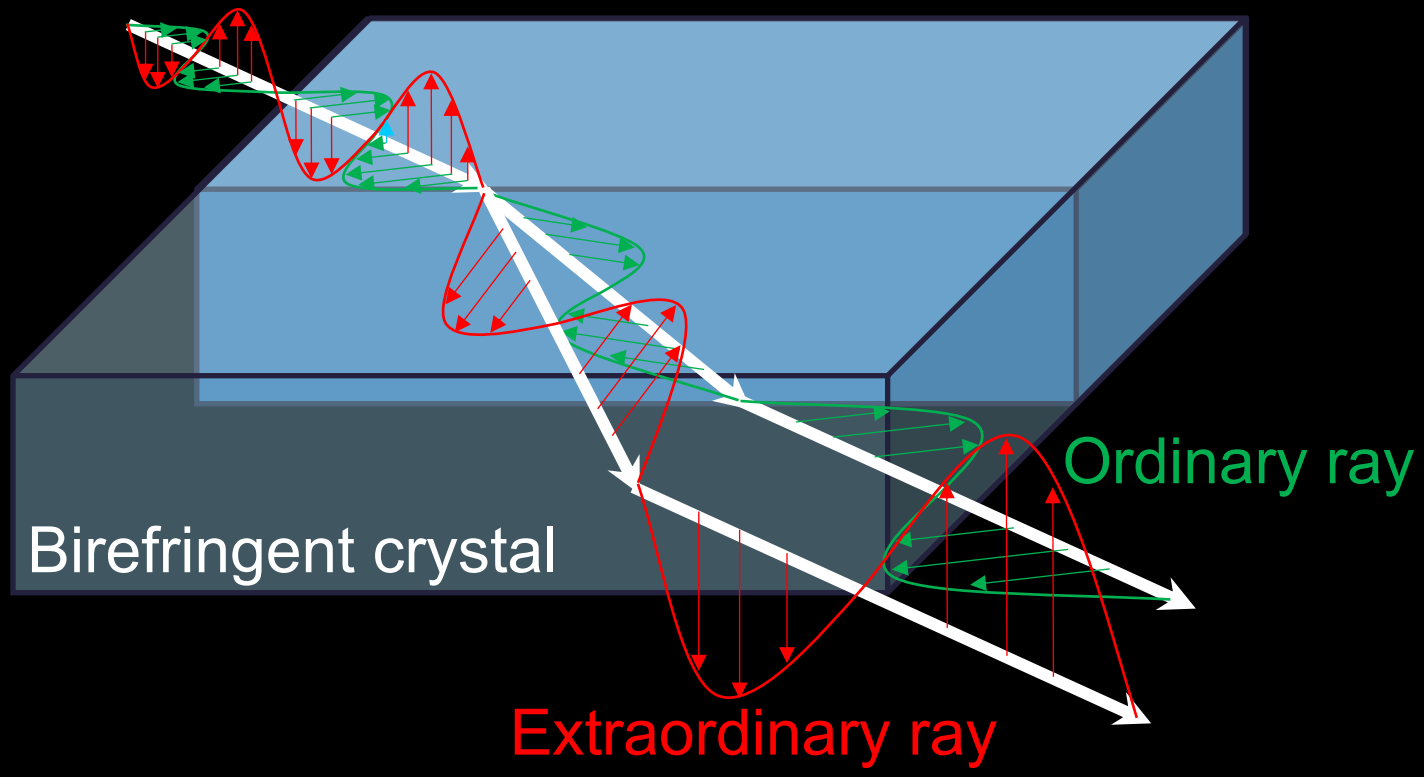
Real time

- User feedback



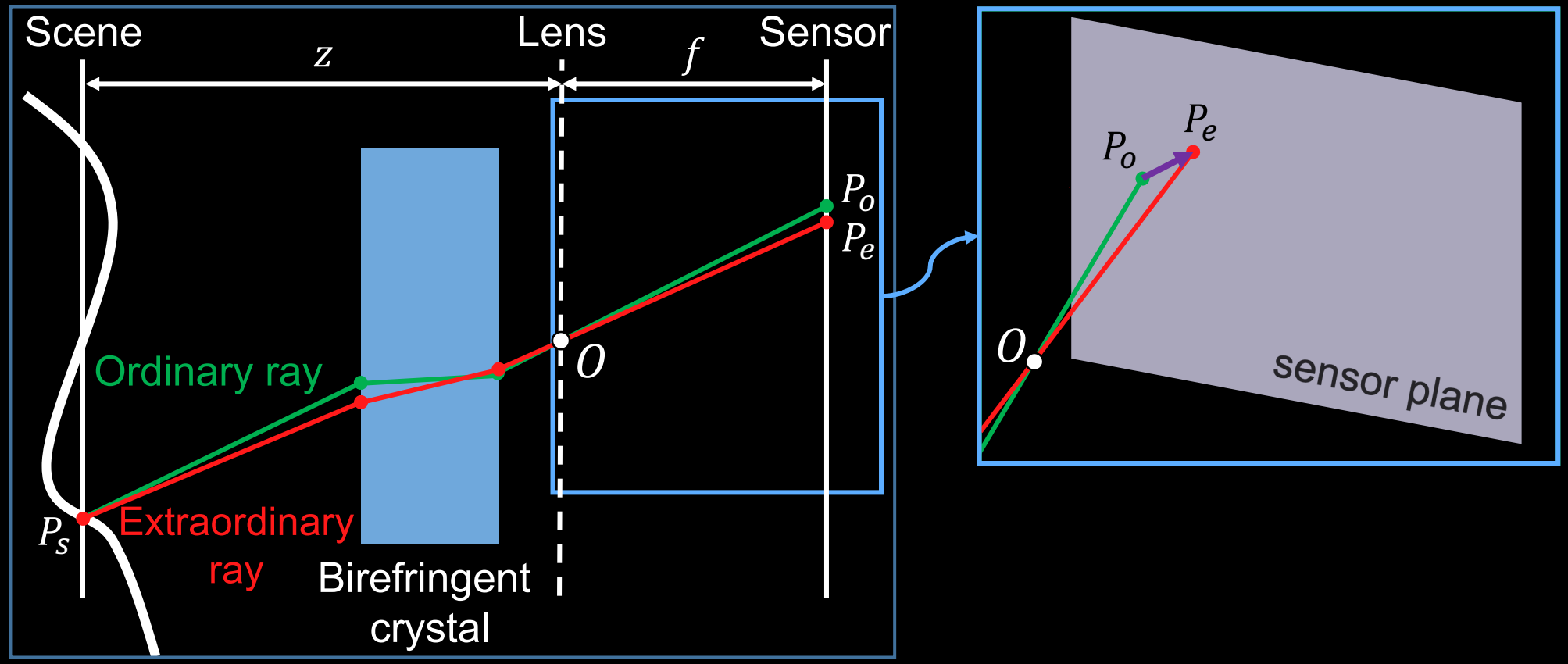
Microsoft

Double Refraction



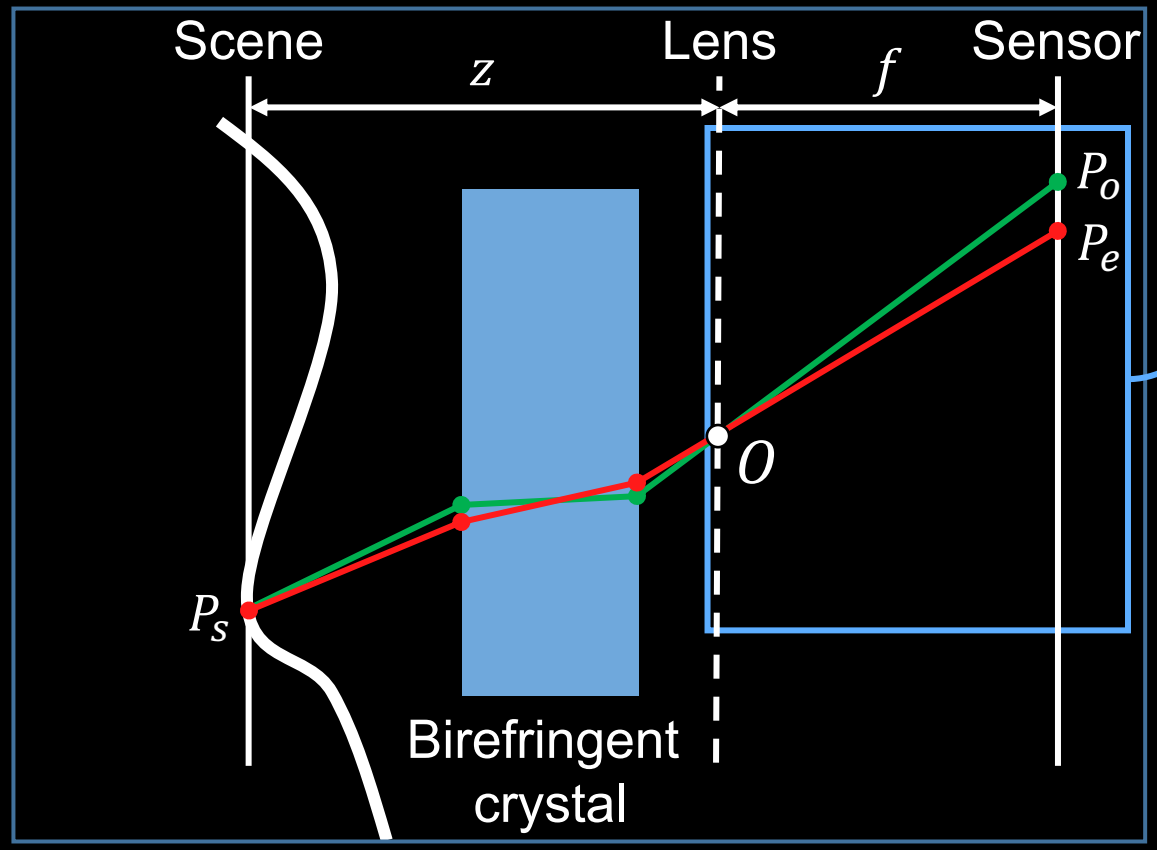
[Baek et al., TOG16]

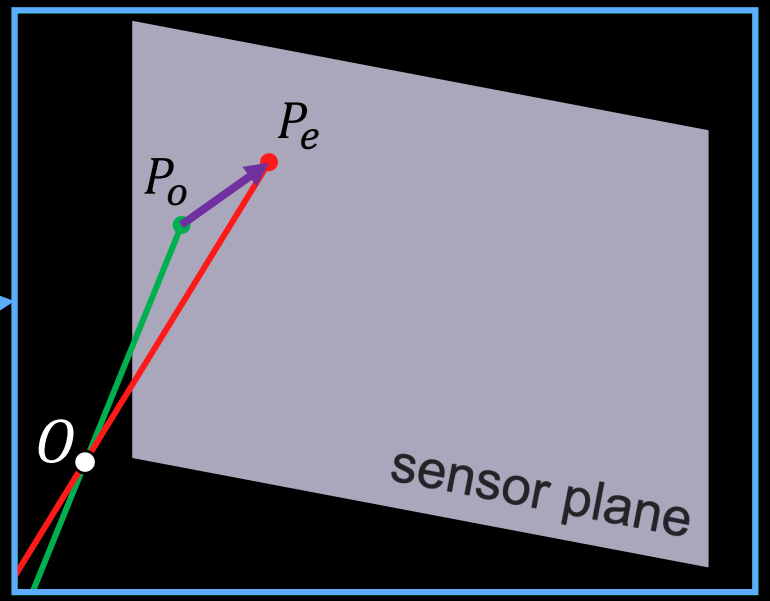
Depth from Double Refraction



[Baek et al., TOG16]

Depth from Double Refraction

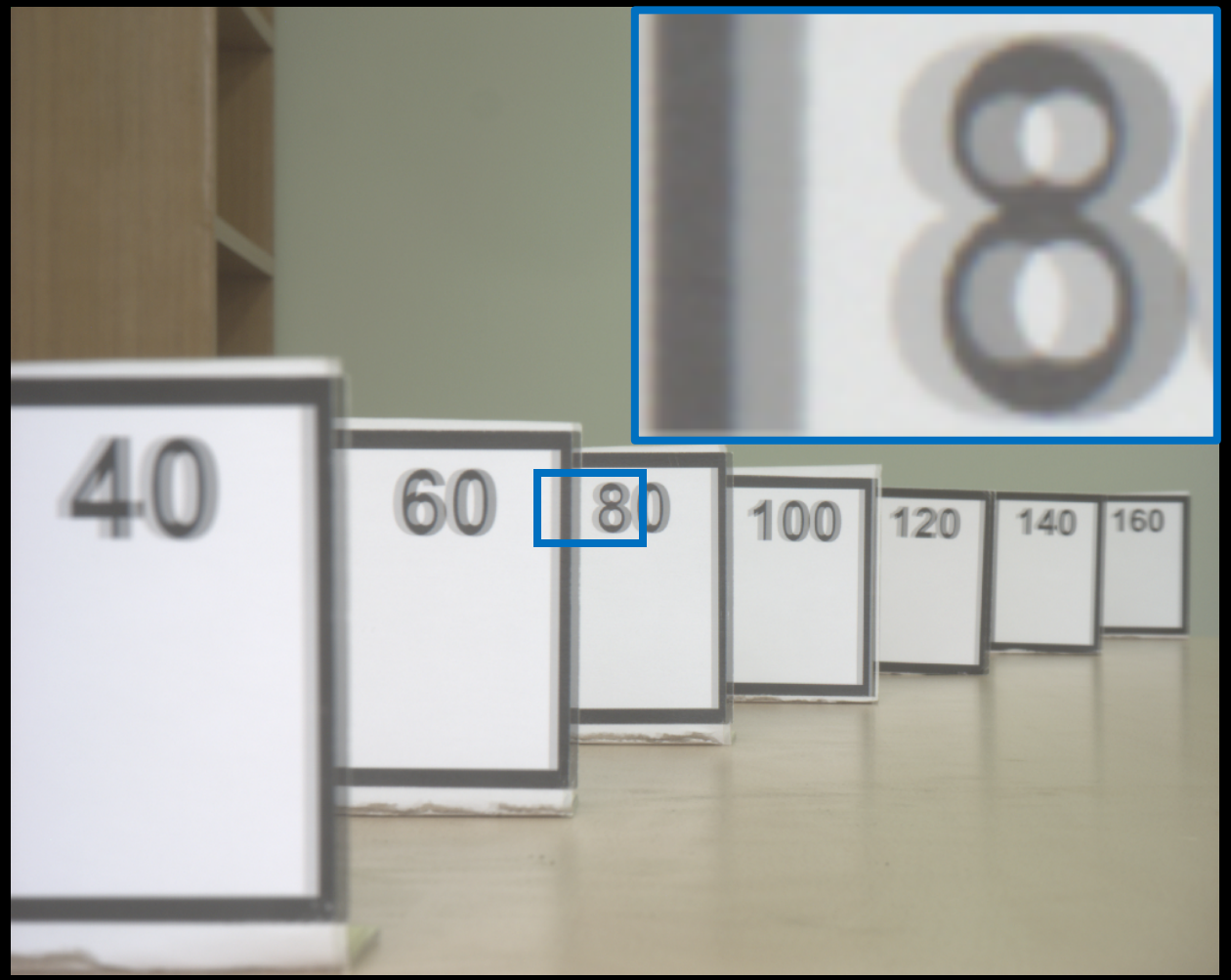




+Single shot
+Passive
+High spatial resolution

[Baek et al., TOG16]

Even Double Refraction



Double refraction

Even intensity of double refraction

↓

Identification problem of the edges

[Baek et al., TOG16]

Challenges of Depth from Double Refraction

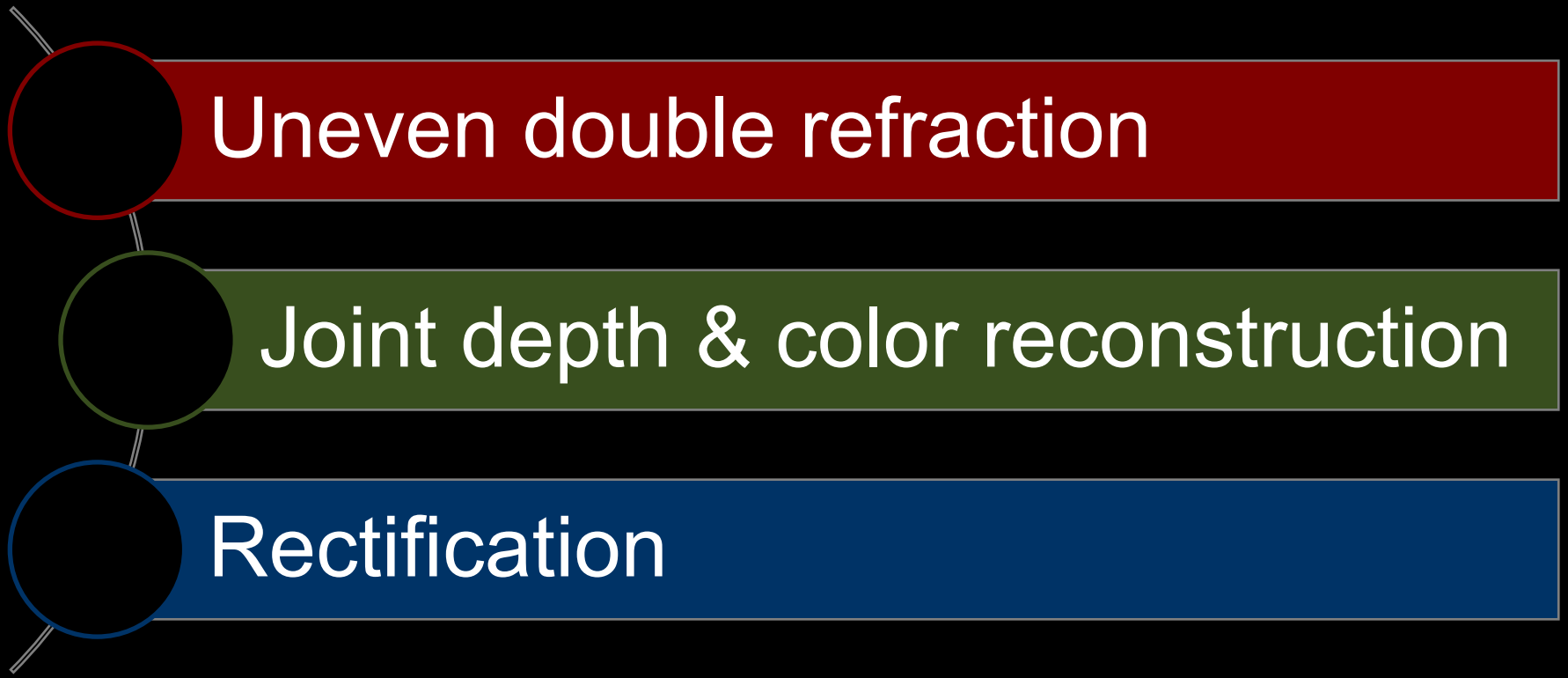
Depth estimation

Image restoration

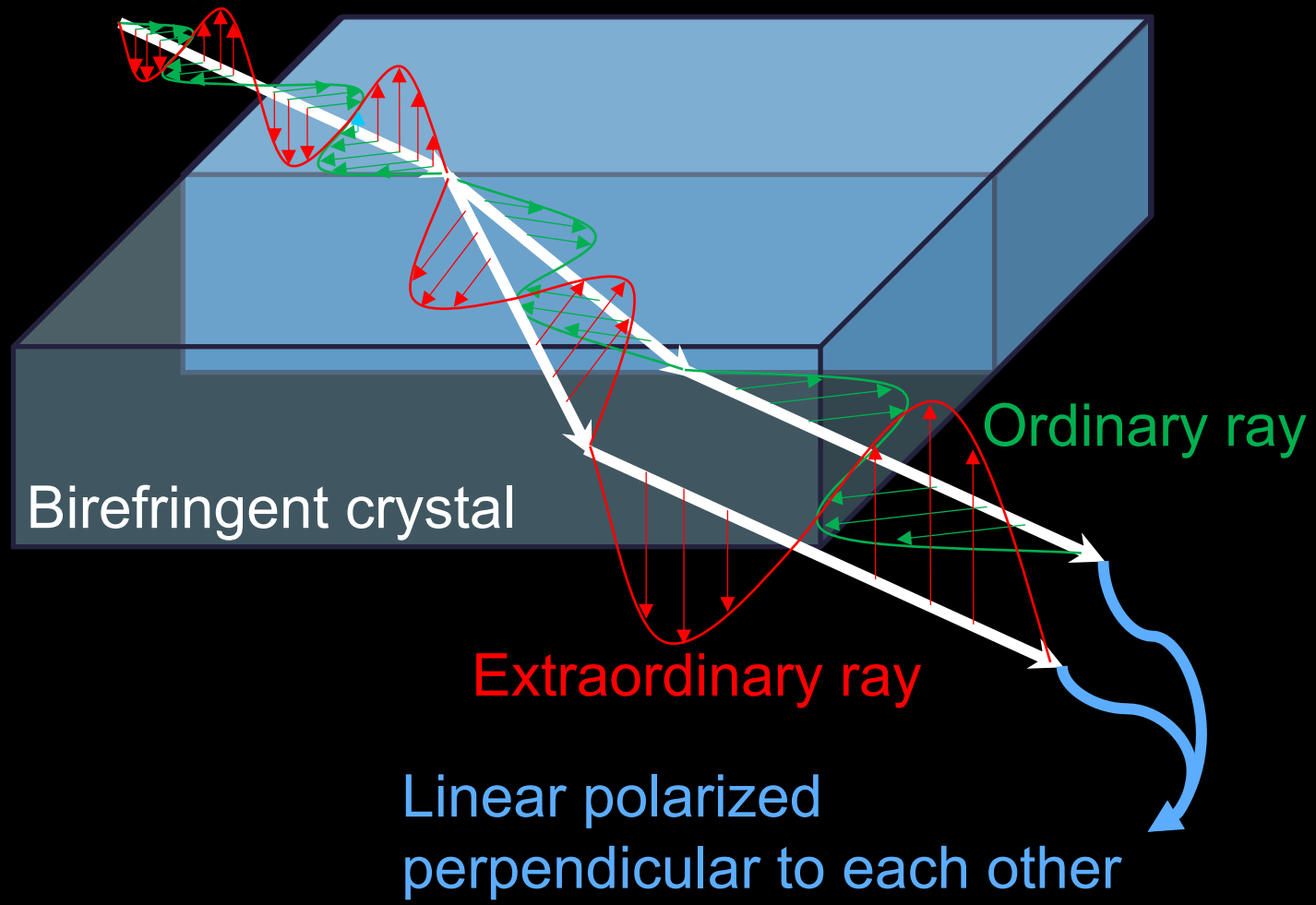
Low computational efficiency
38 sec. @ 2048 x 1500 pixels

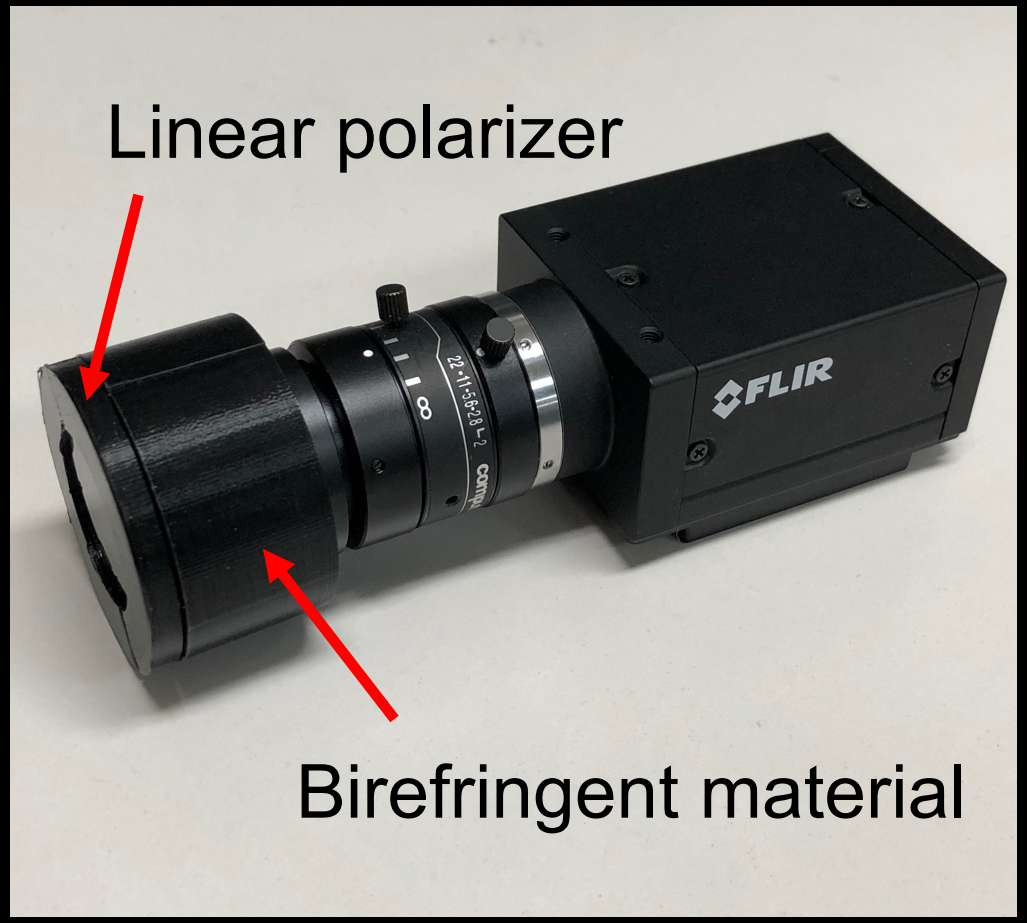
Restored color image
with deconvolution artifacts

Technical Contributions

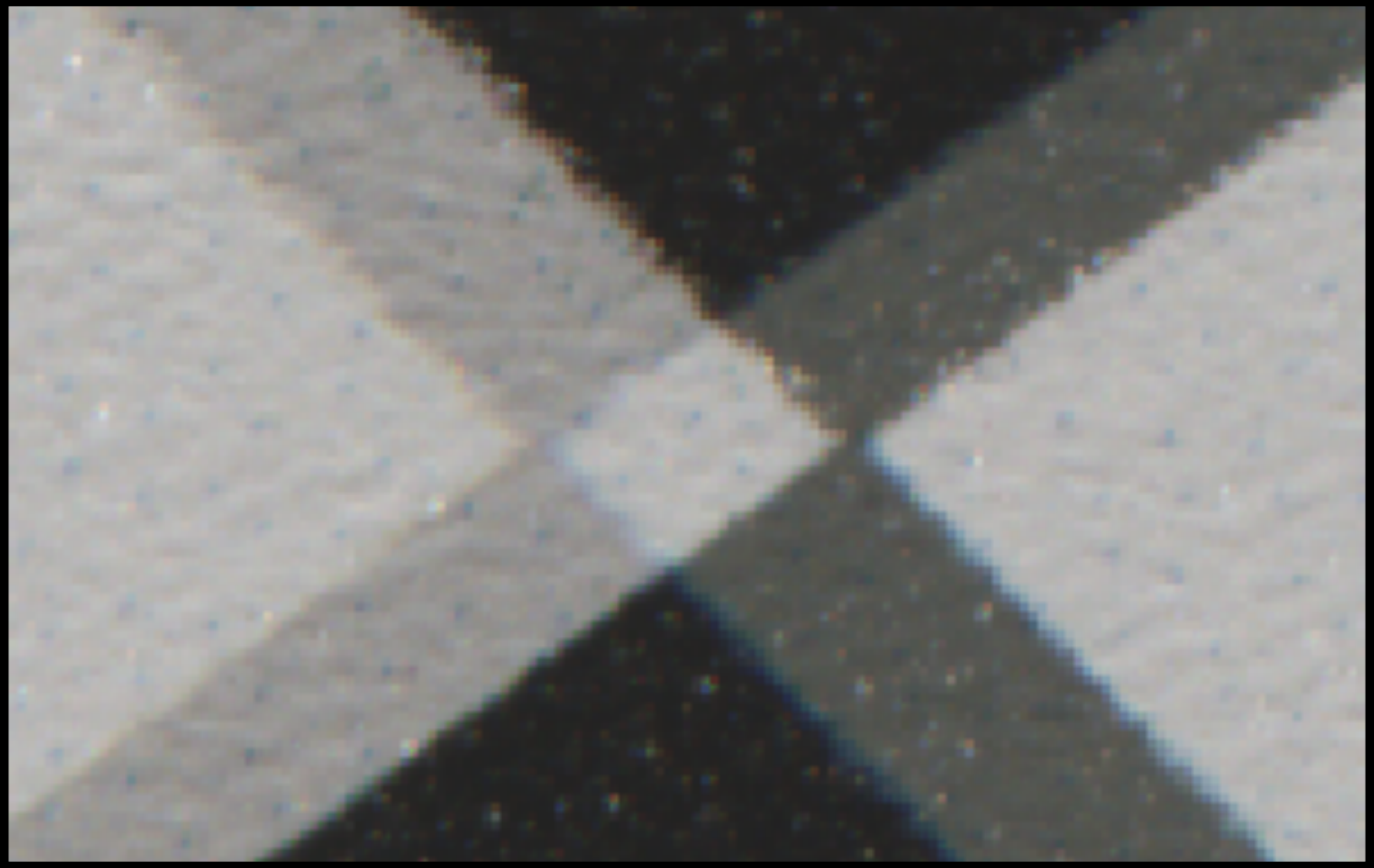


Cross Polarization of Double Refraction

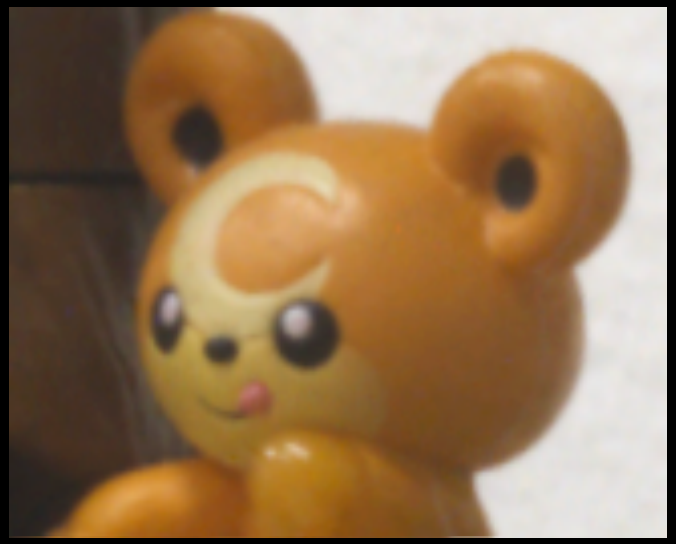




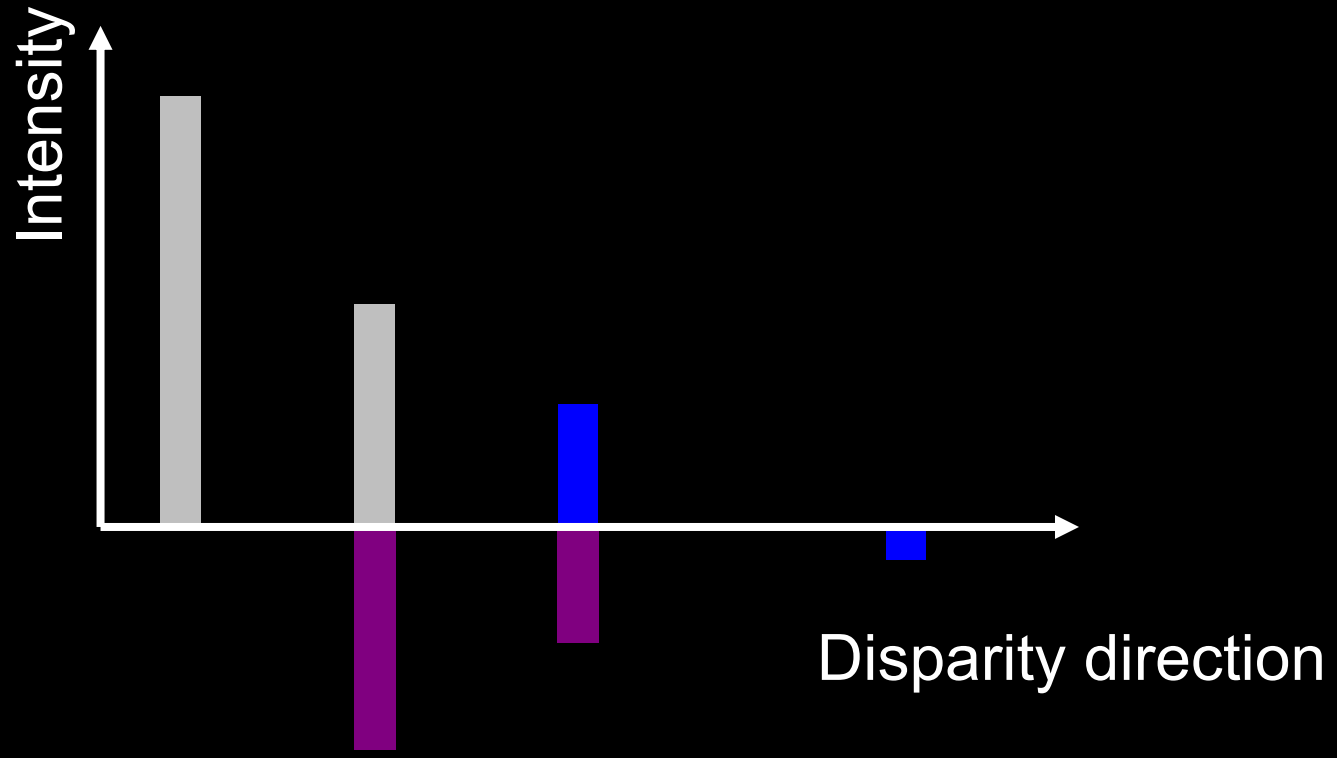
Uneven Double Refraction



Joint Reconstruction of Depth and Image



Reference image

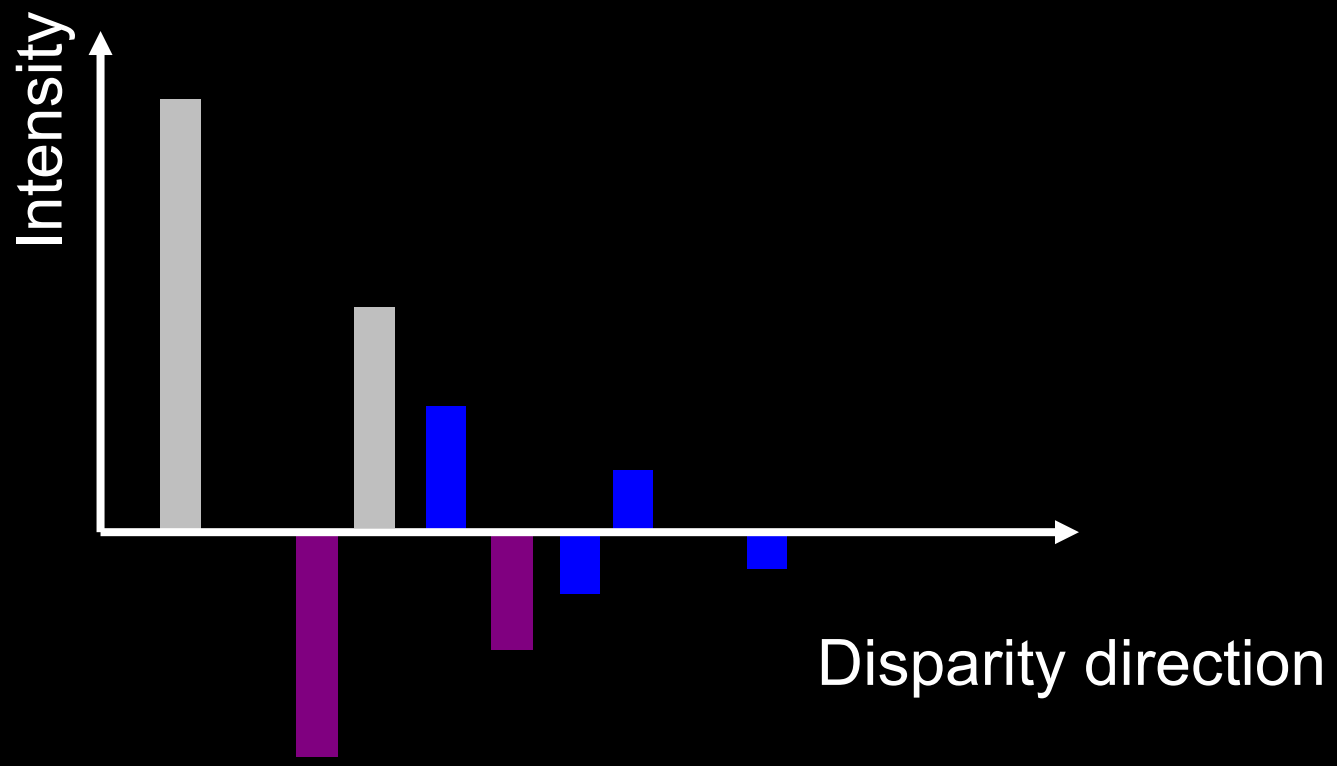


Depth samples: $\{z_1, z_2, \ldots, z_{N-1}, z_N\}$

Joint Reconstruction of Depth and Image

Restored image

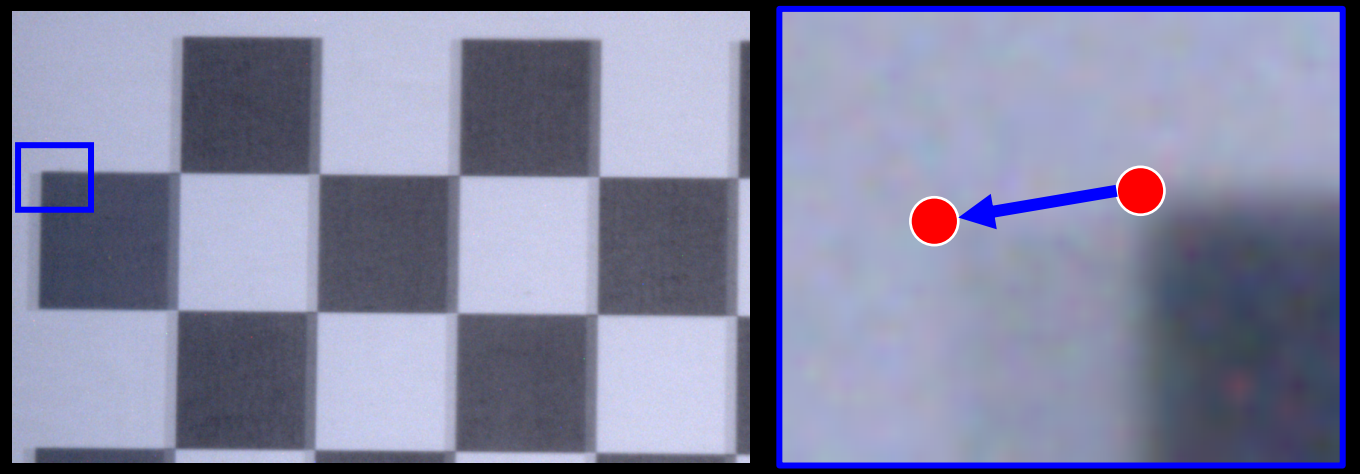
Input image

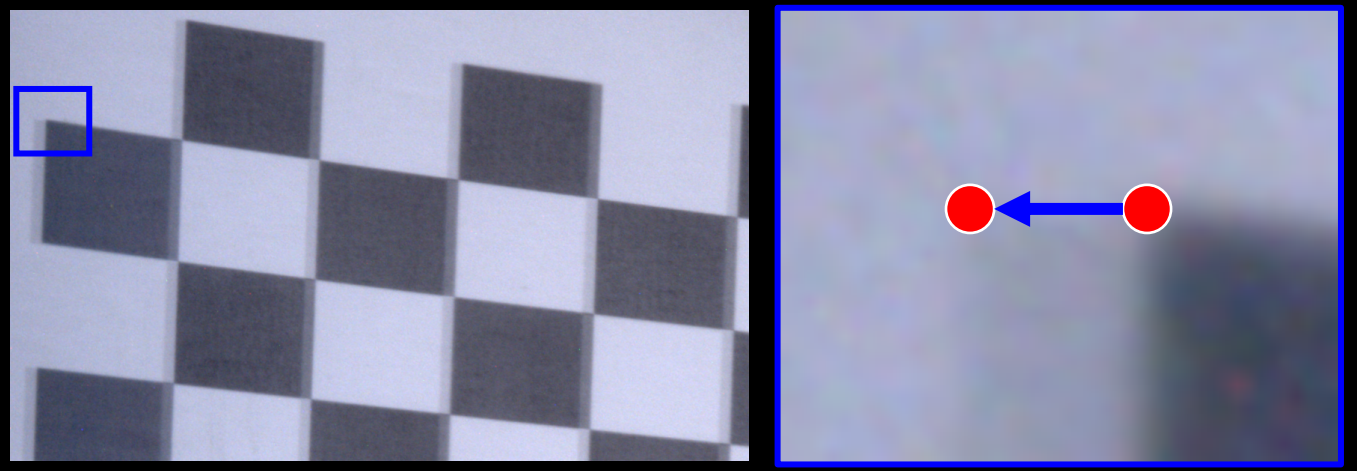


Depth samples: $\{z_1, z_2, \ldots, z_{N-1}, z_N\}$

Rectification

Spatially-varying disparity

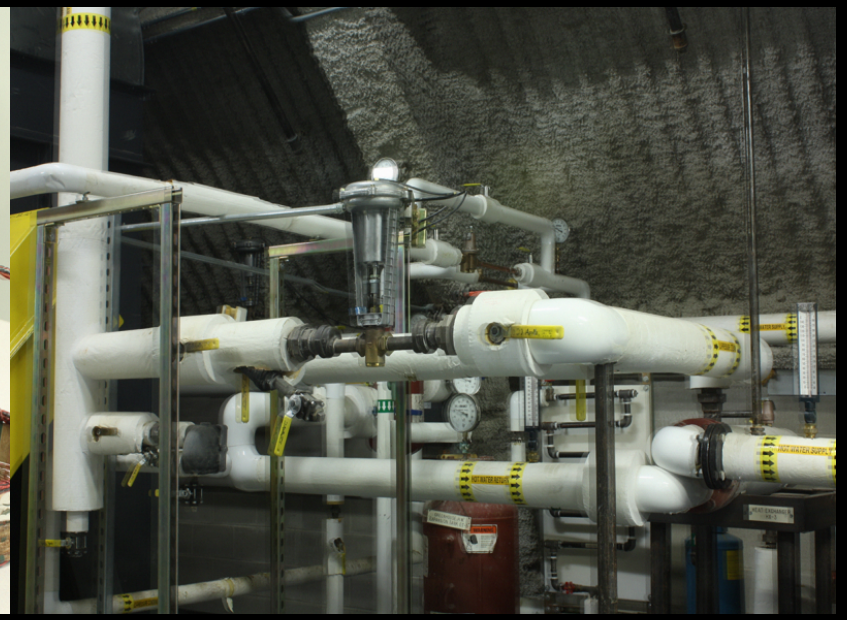


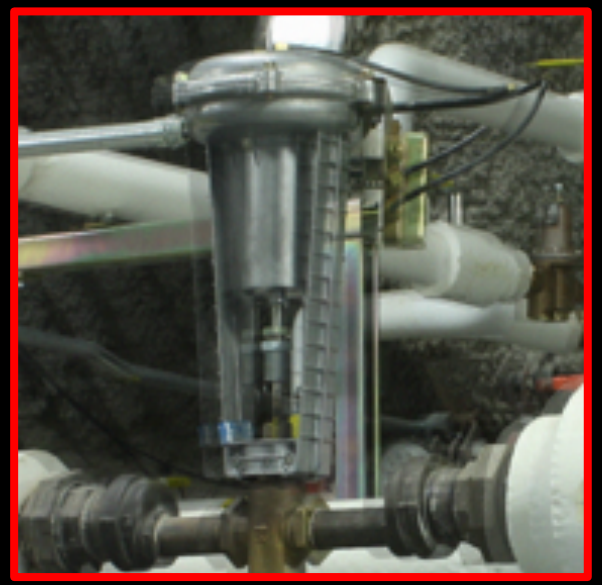


Spatially-invariant disparity

Simulation Results: Input





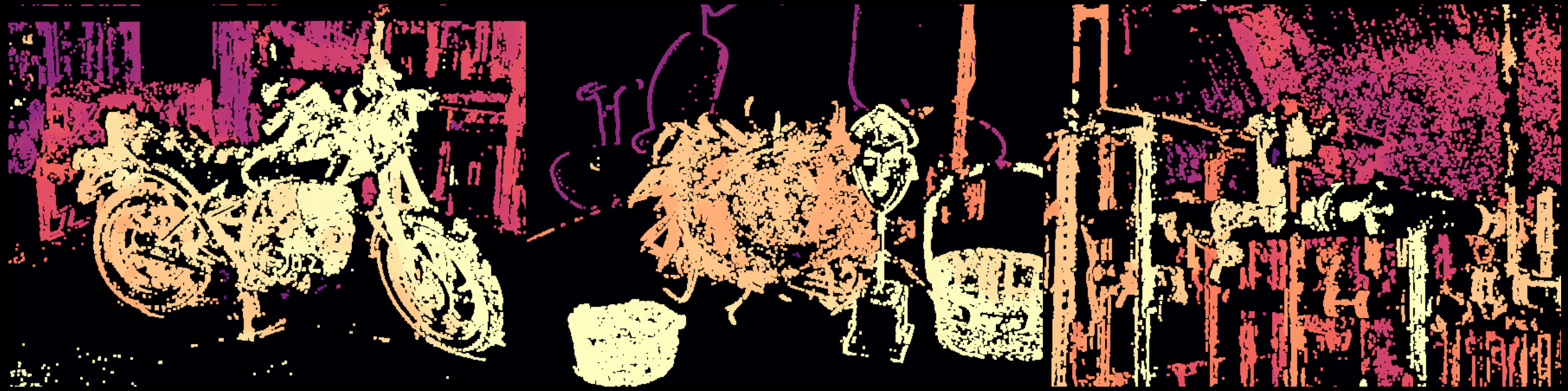



Simulation Results: Restored Image

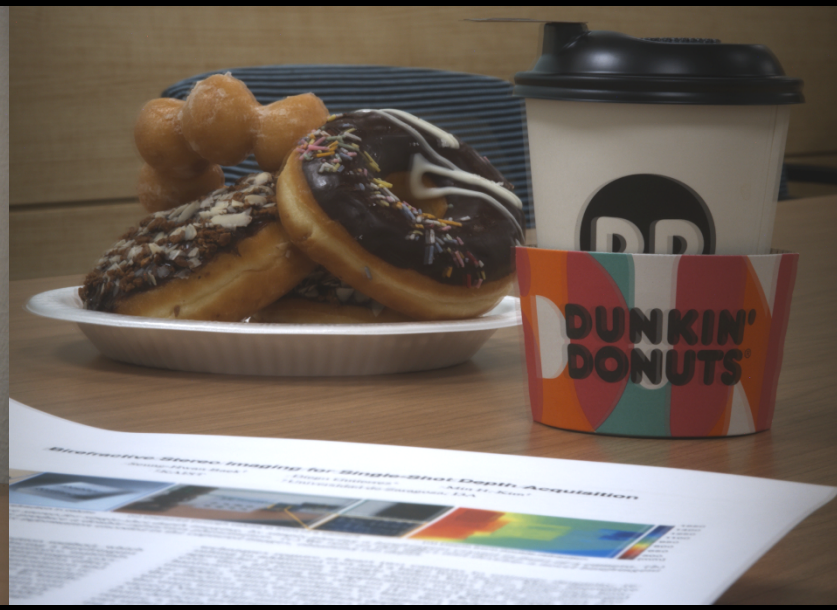





Simulation Results: Estimated Depth



Real-world Results: Input



Real-world Results: Restored Image

Real-world Results: Estimated Depth



FOUR

Conclusion

- Monocular RGB-D imaging
  - Real-time
  - Single-shot
  - Passive

https://github.com/KAIST-VCLAB/fastbirefstereo




Andreas Meuleman* Seung-Hwan Baek* Felix Heide Min H. Kim

* Equal contribution

Narrated by Mustafa Yaldiz