Realistic Image Synthesis

research at MPI Informatik

Philipp Slusallek

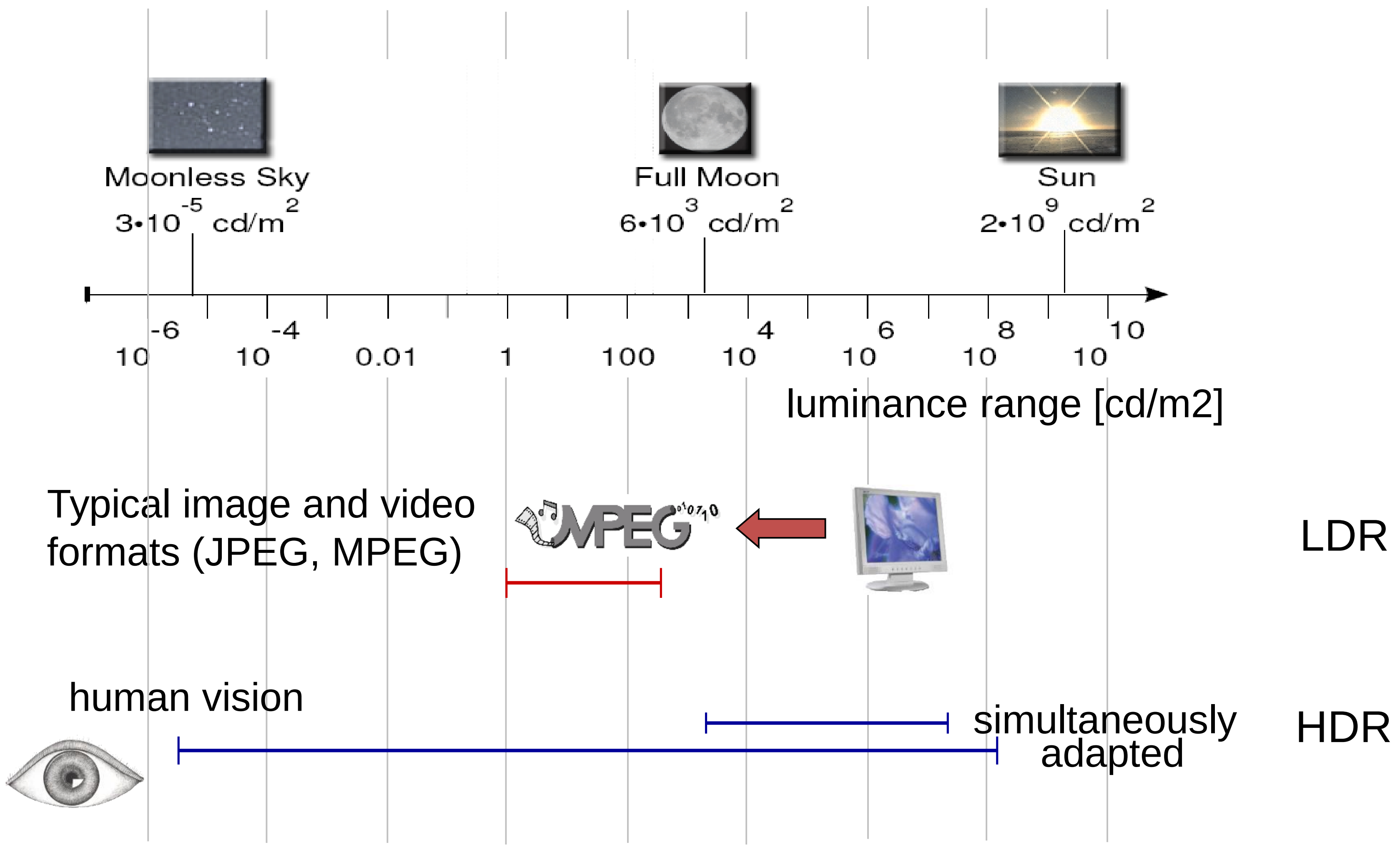
Karol Myszkowski

Gurprit Singh

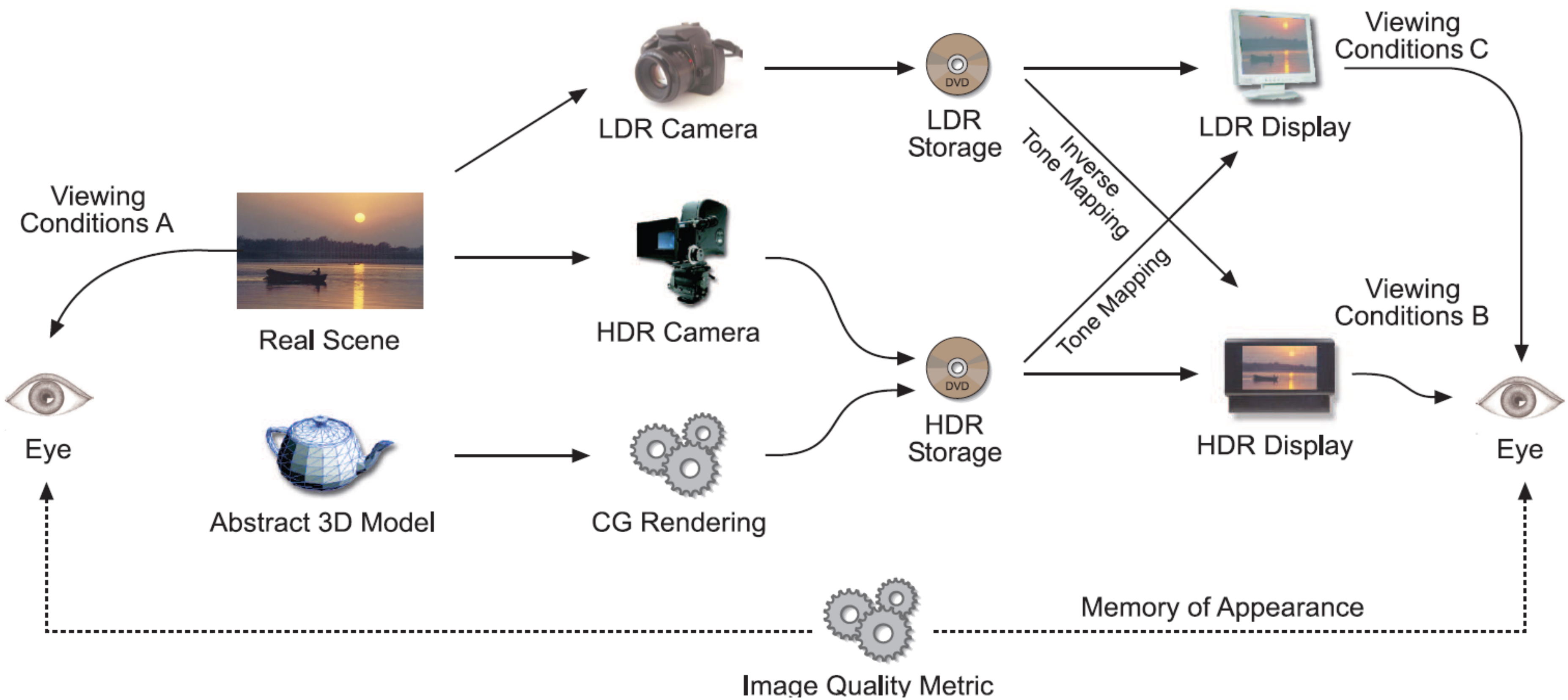
Research From Saarbrücken

- Some examples

High Dynamic Range (HDR) Imaging

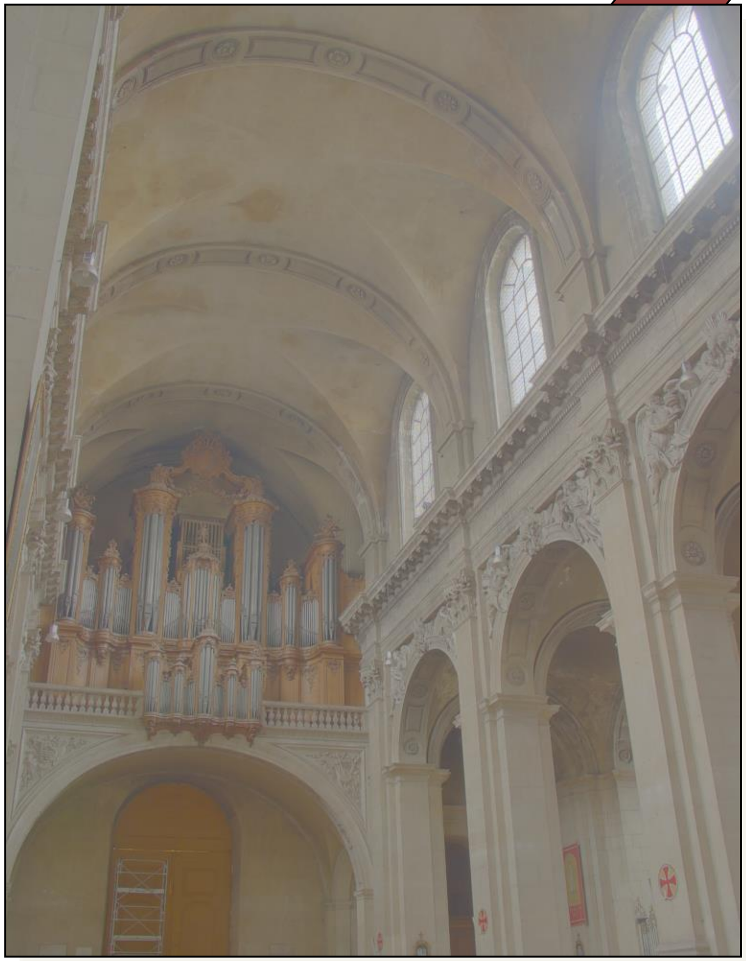


HDR Imaging Pipeline

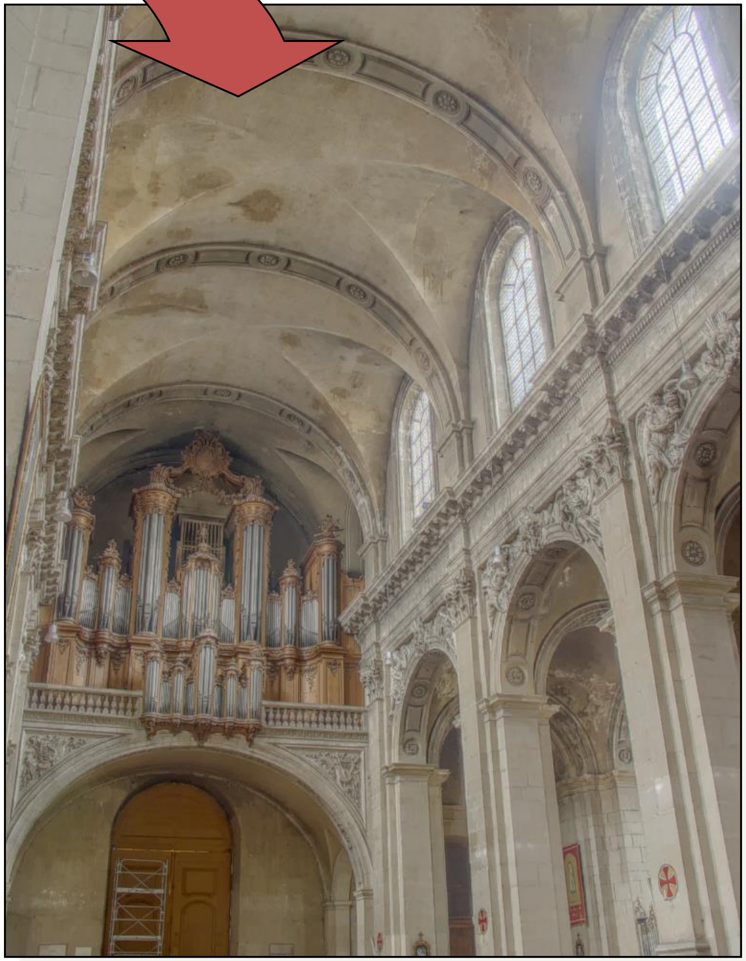


Tone Mapping

Naïve
non-linear compression



Advanced
contrast perception model



MPI HDR Software

PFSTools
For High Dynamic Range Images and Video

http://pfstools.sourceforge.net/

PFStmo
tone mapping operators

http://www.mpii.mpg.de/resources/tmo/

PFScalibration
Photometric Calibration of HDR and LDR Cameras

http://www.mpii.mpg.de/resources/hdr/calibration/pfs.html

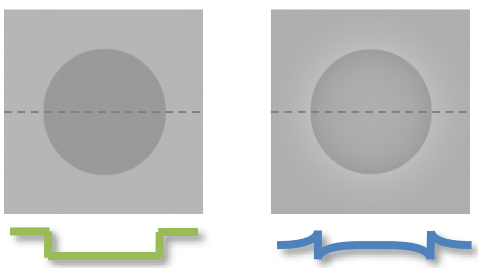
HDR Visual Difference Predictor

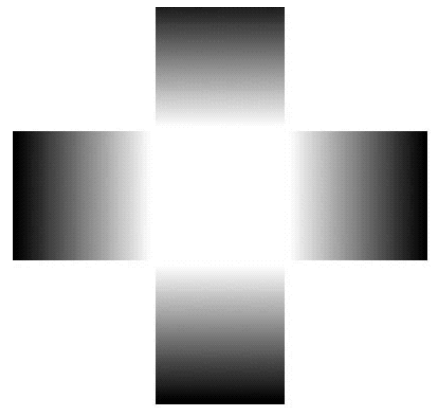
http://www.mpi-sb.mpg.de/resources/hdr/vdp/index.html

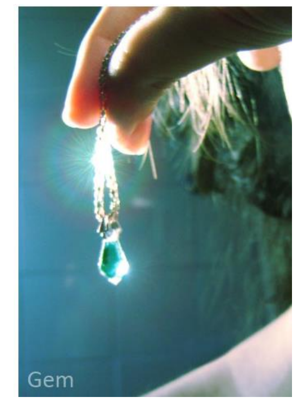
GPL License

Overcoming Display Limitations

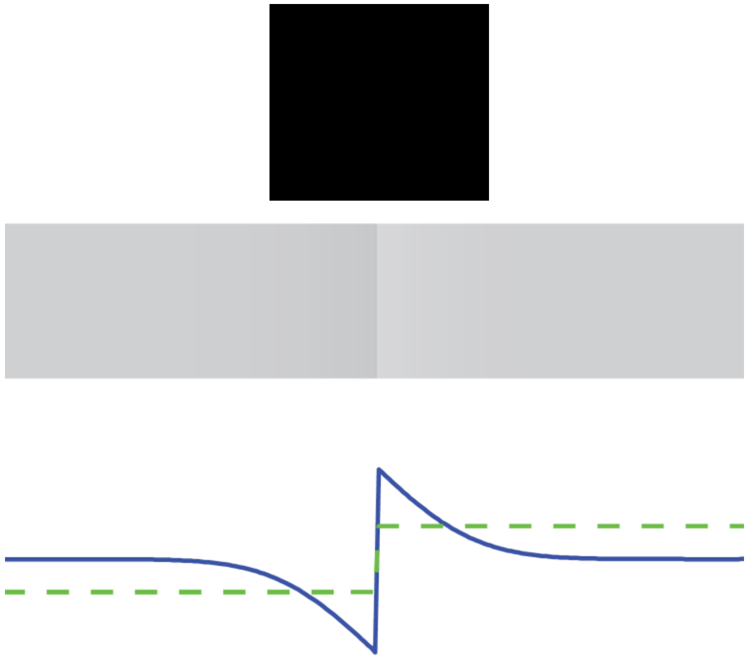
- Enhancing apparent (perceived) quality rather than improving technical aspects
- Take advantage of the visual system properties



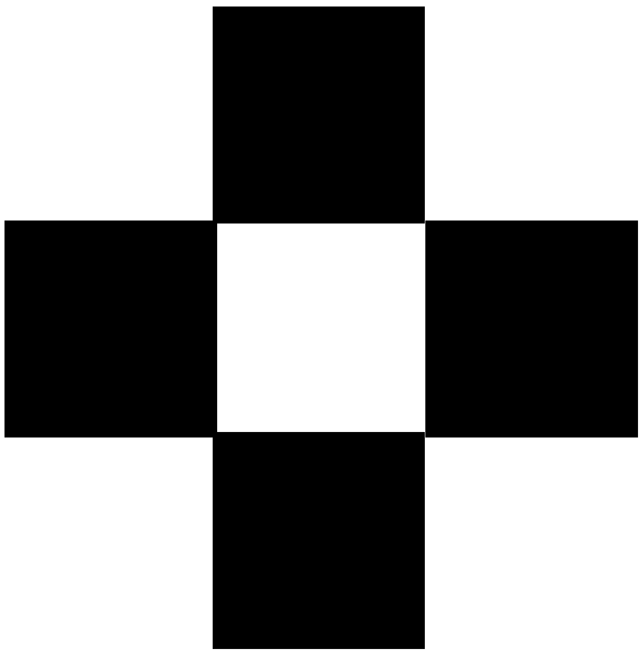


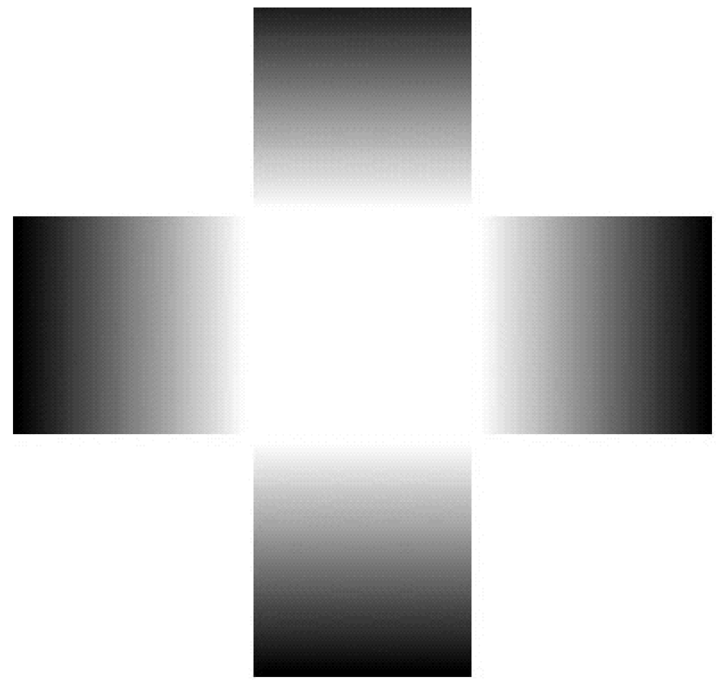


Cornsweet Illusion



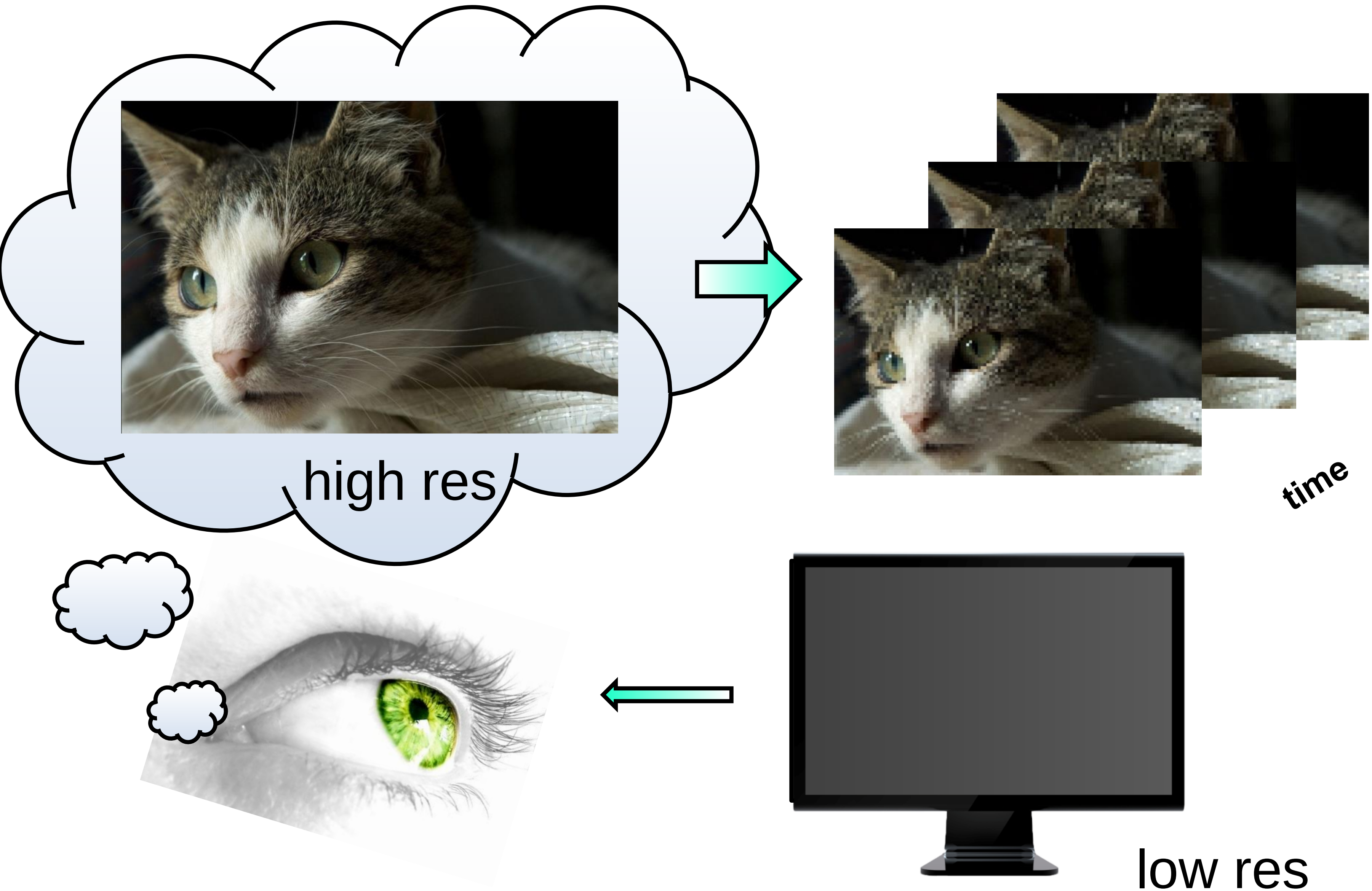
Glowing Effect



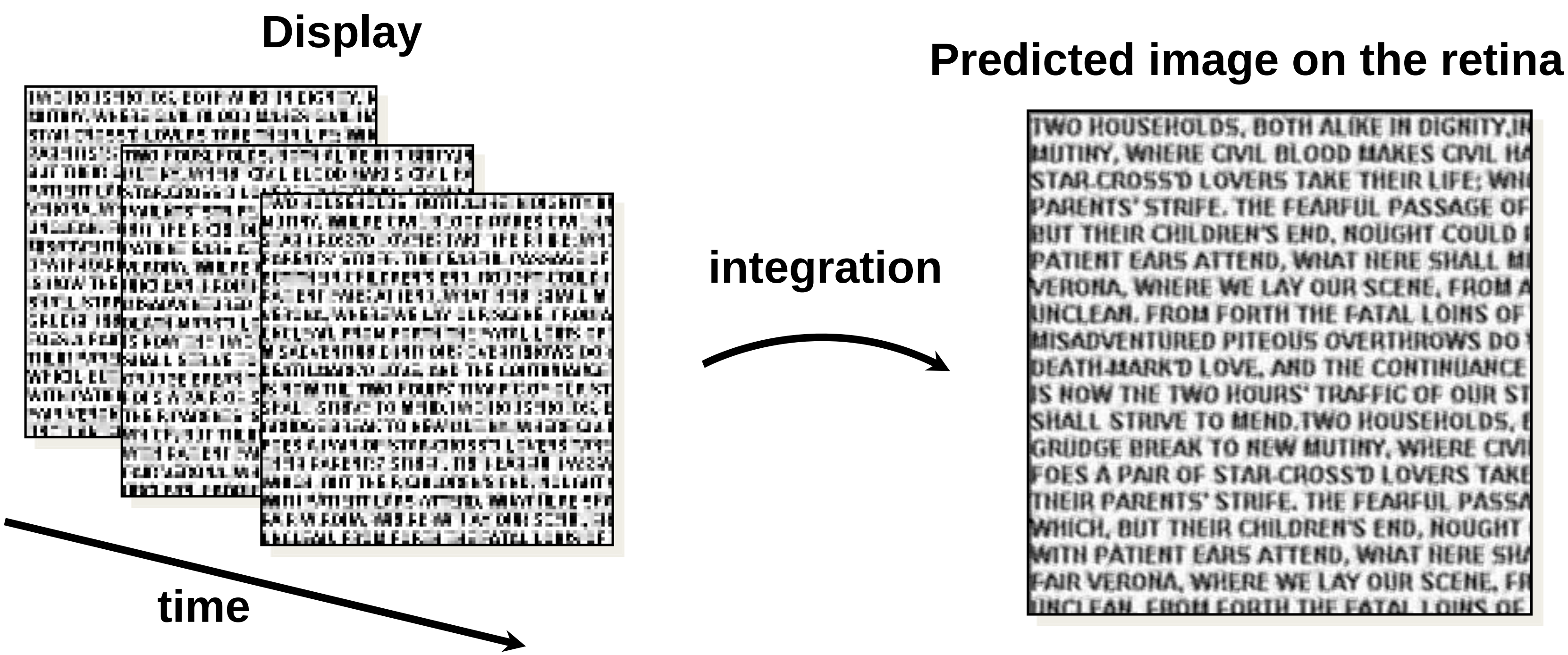


[Zavagno and Caputo 2001]

Apparent Resolution Enhancement



Optimization Result



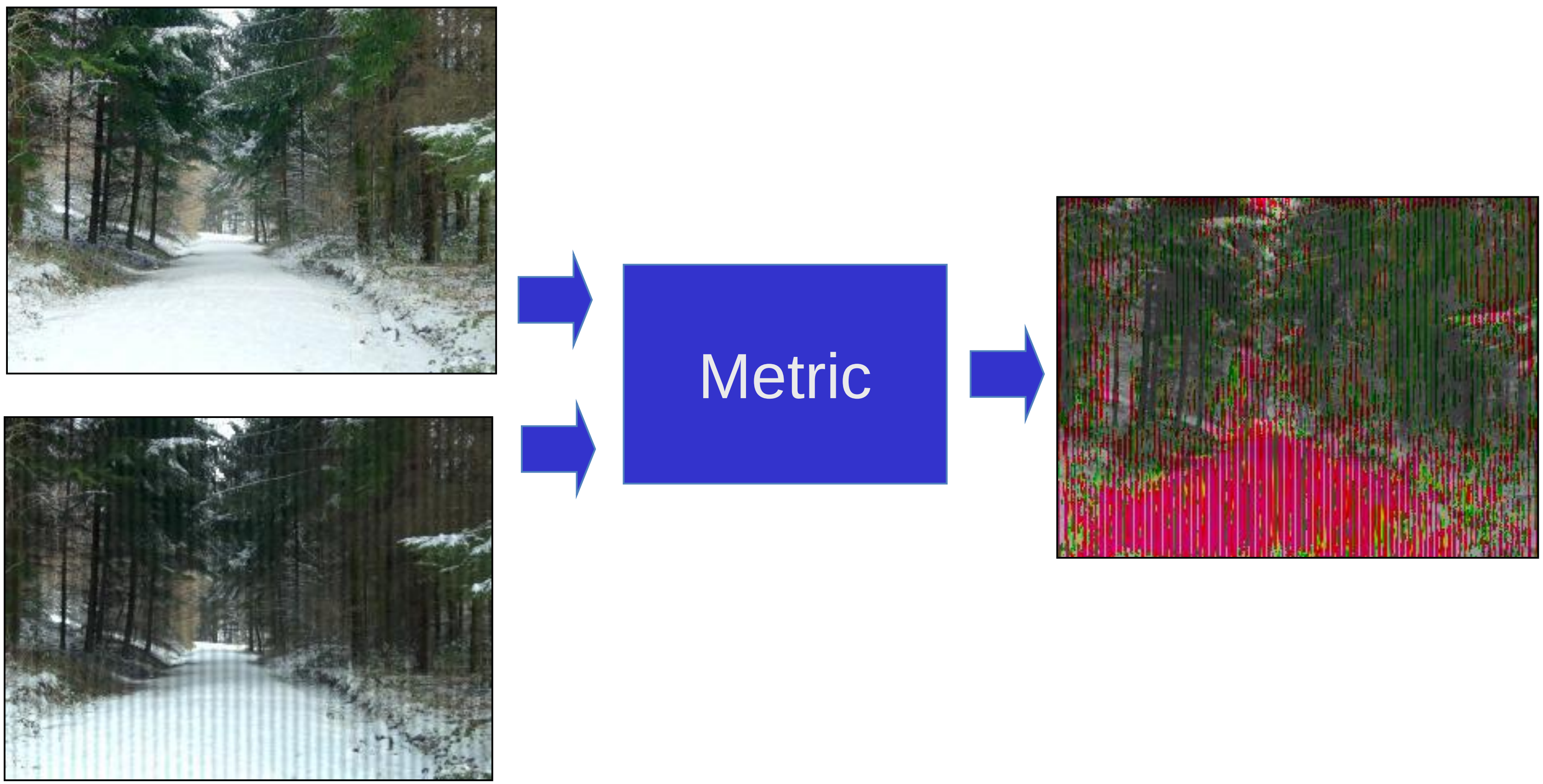
3D Image Retargeting

Input devices
Produce different depth ranges

Output devices
Reproduce different depth ranges

Visible Difference Metric (VDP)

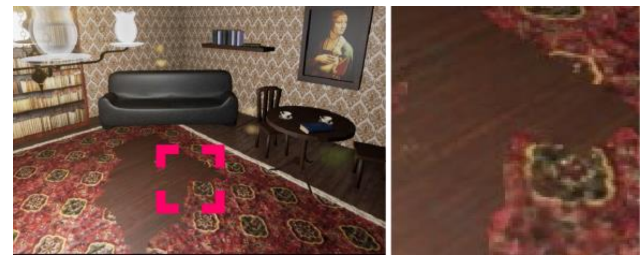
- Can the human eye see the differences between two images?



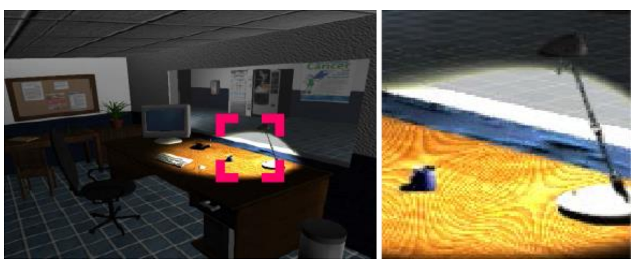
Dataset of Visible Distortions

Peter Panning

Z-fighting



Shadow acne



Shadowmap downsampling

[Piórkowski et al. 2017]

Dataset of Visible Distortions

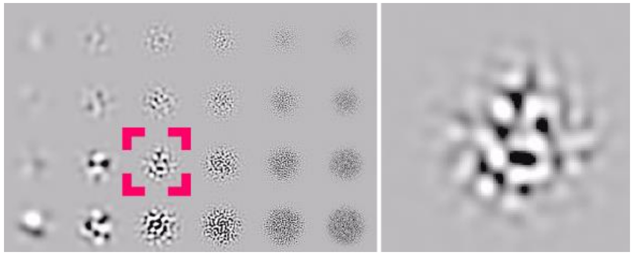
Aliasing

[Piórkowski et al. 2017]

IBR

[Adhikarla et al. 2017]

Perception patterns

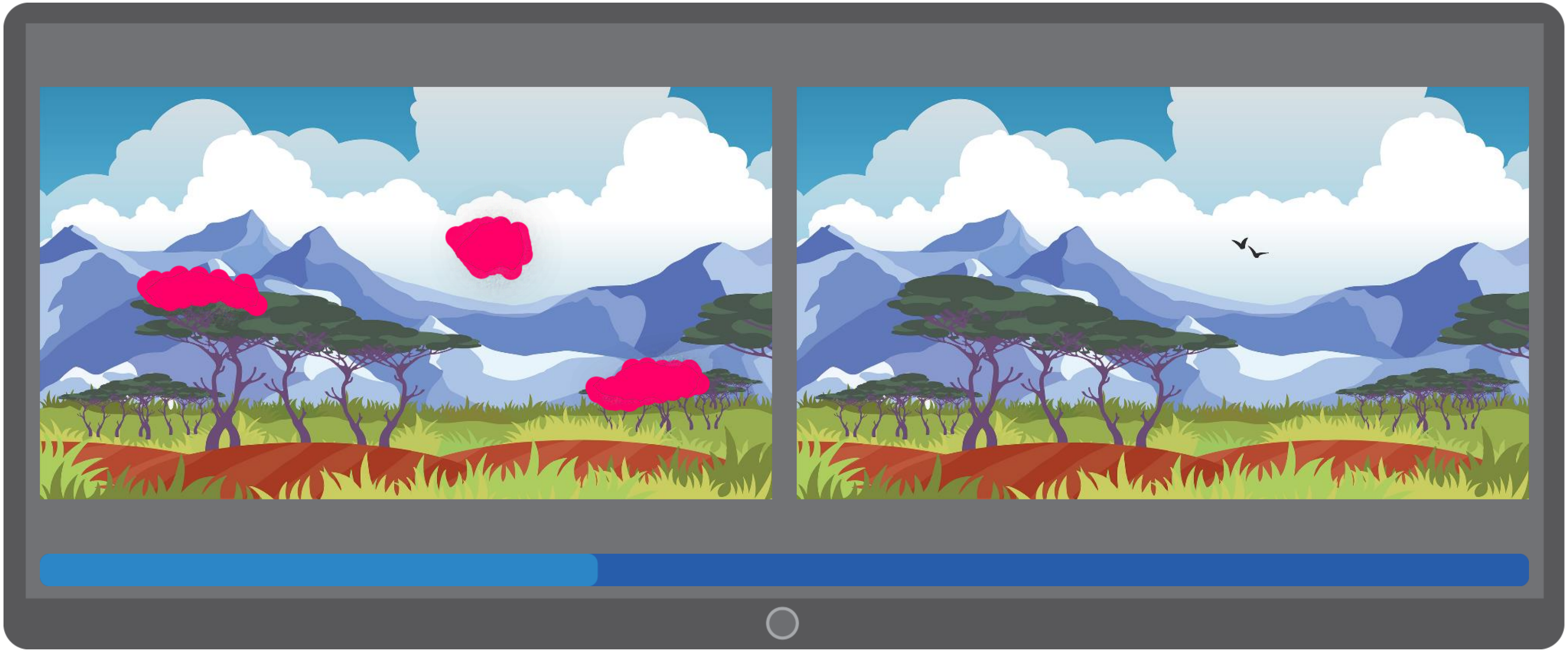


[Čadík et al. 2013]

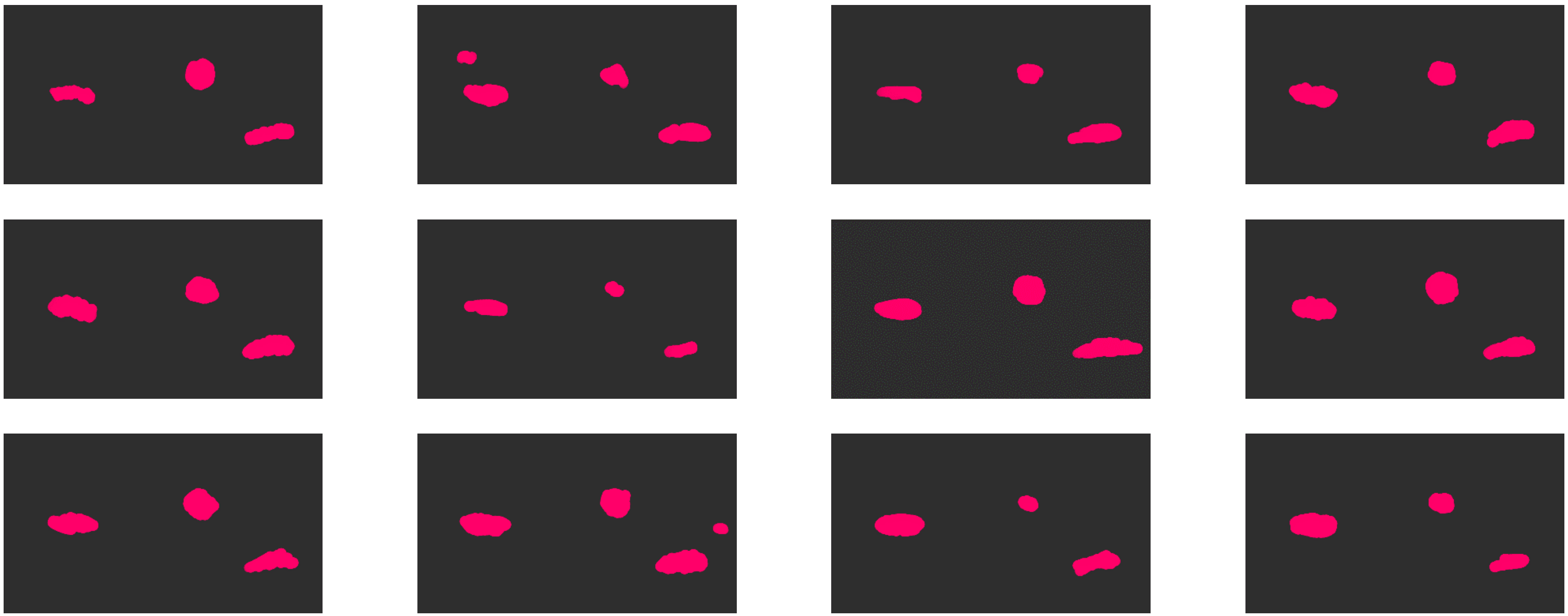
Deghosting

[Karađuzović-Hadžiabdić et al. 2017]

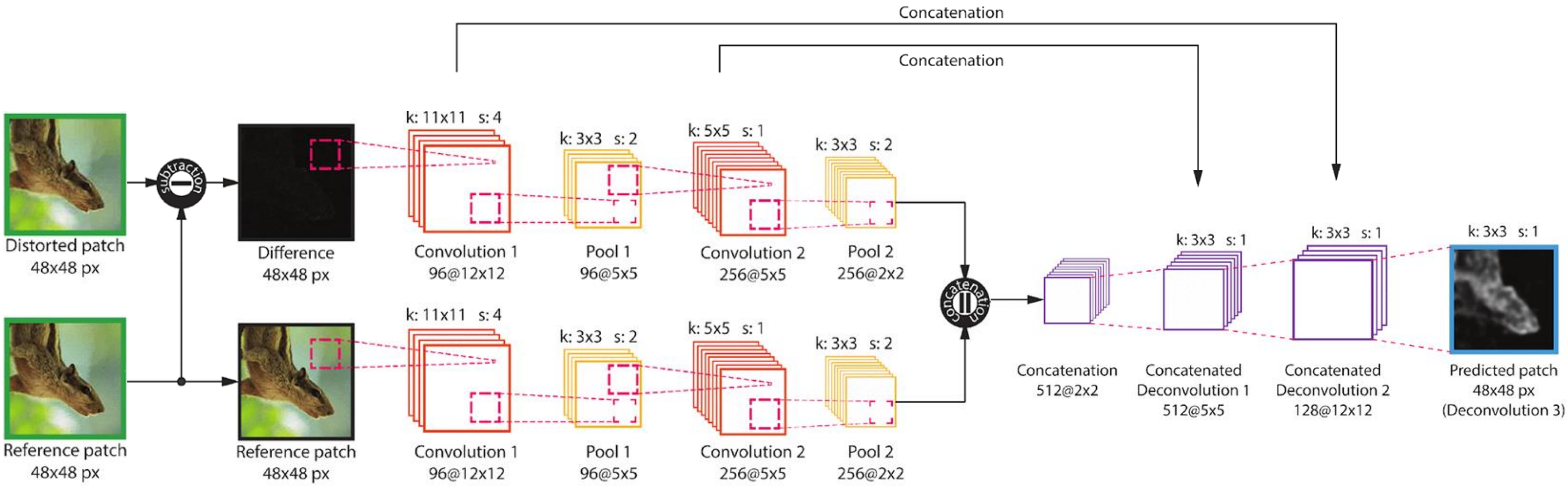
Label Creation



Label Creation



Neural Network Architecture



Multi-material Printing

Stratasys J750 (poly-jetting printer)

Cyan

Magenta

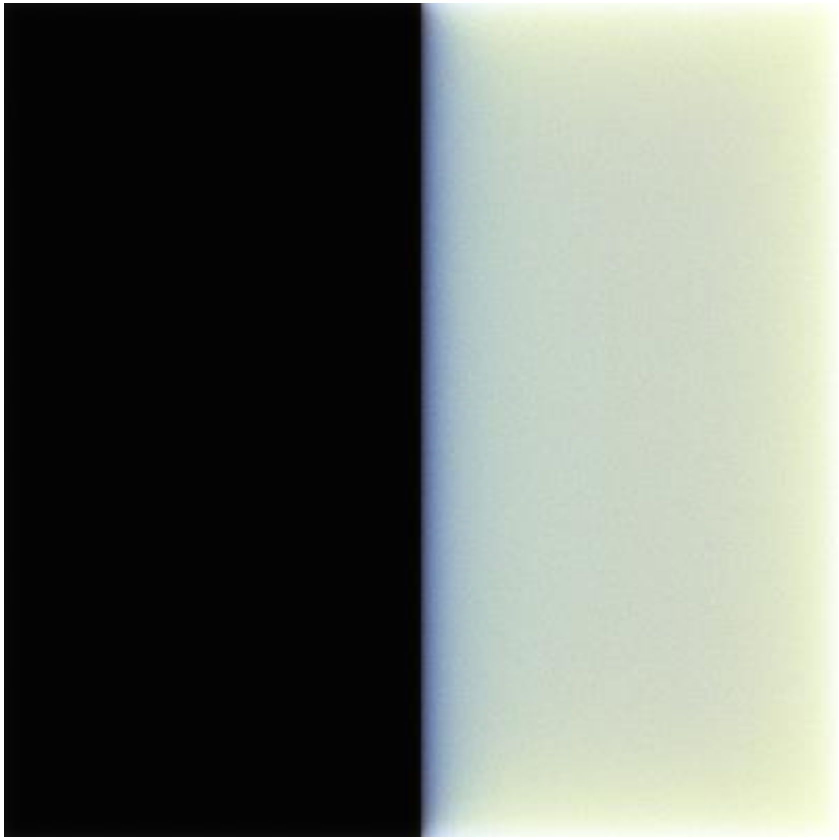
Yellow

blacK

White

Vero Opaque materials
(not actually opaque!)

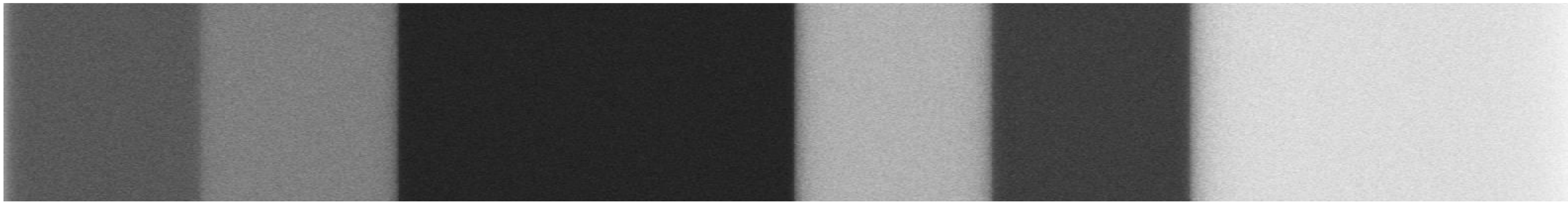
3D Appearance Printing



Goal: Visually Reducing Light Diffusion in the 3D Printed Material

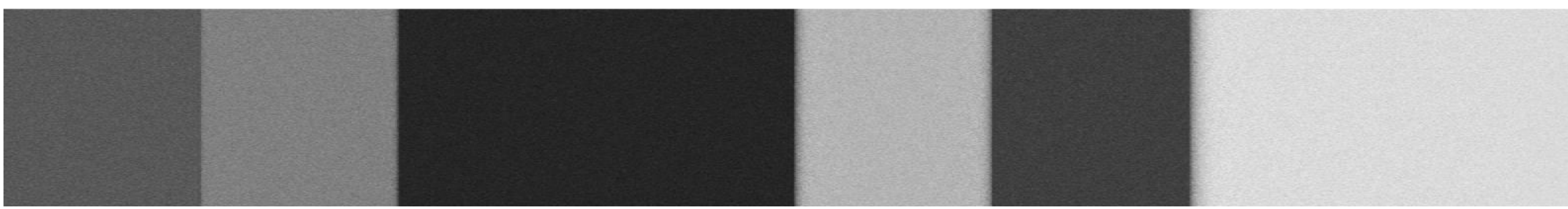
3D Appearance Printing

Without correction (MC simulation)

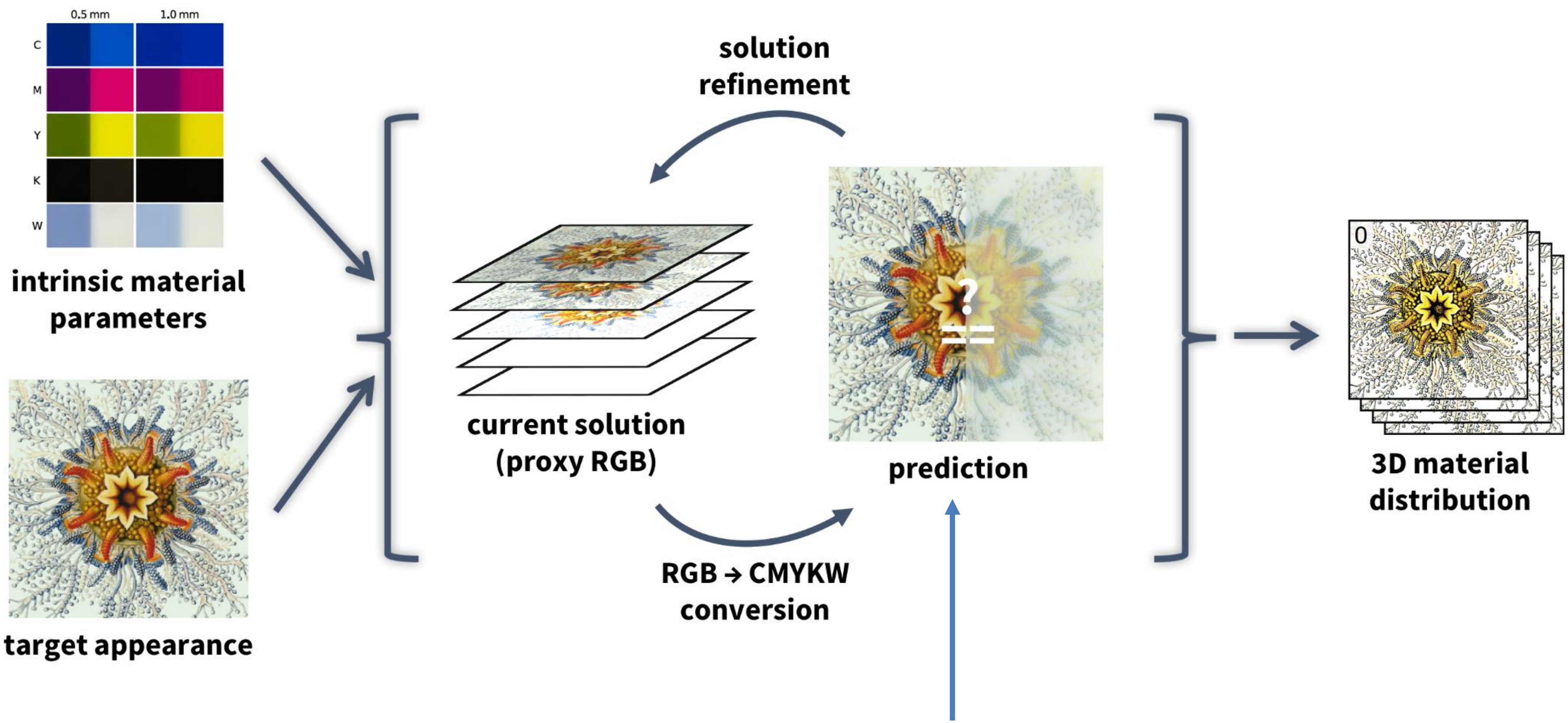


Target texture

With correction (MC simulation)

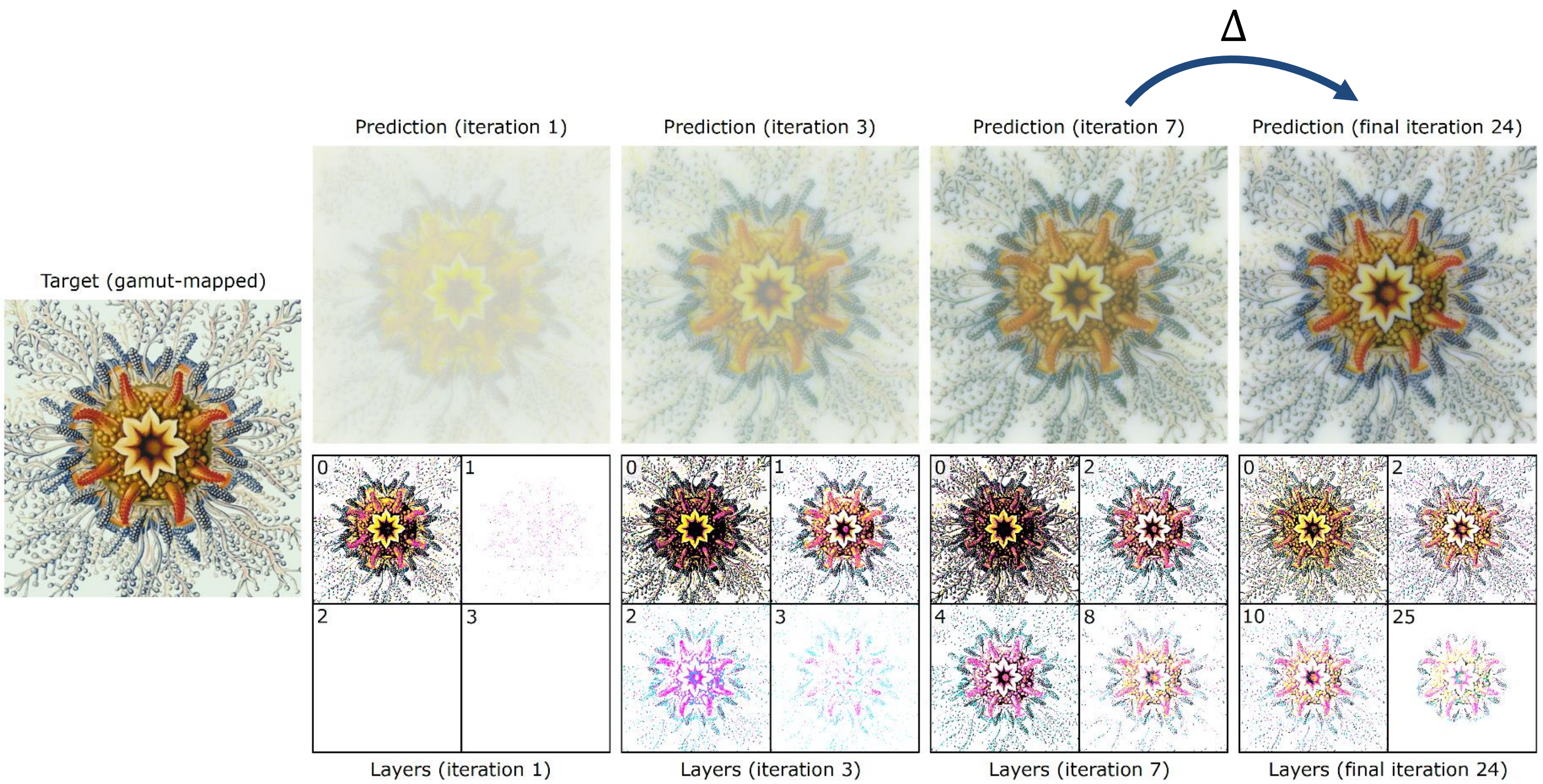


3D Appearance Printing



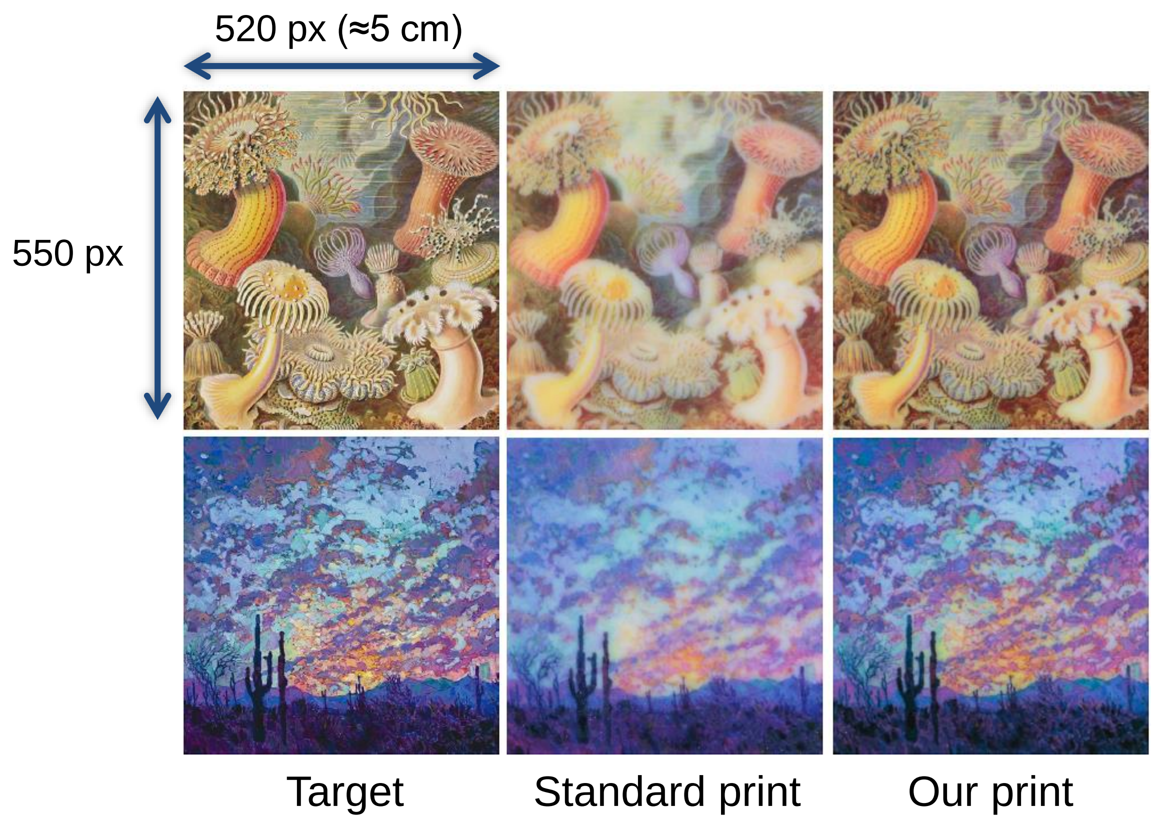
Volumetric MC global illumination simulation

3D Appearance Printing

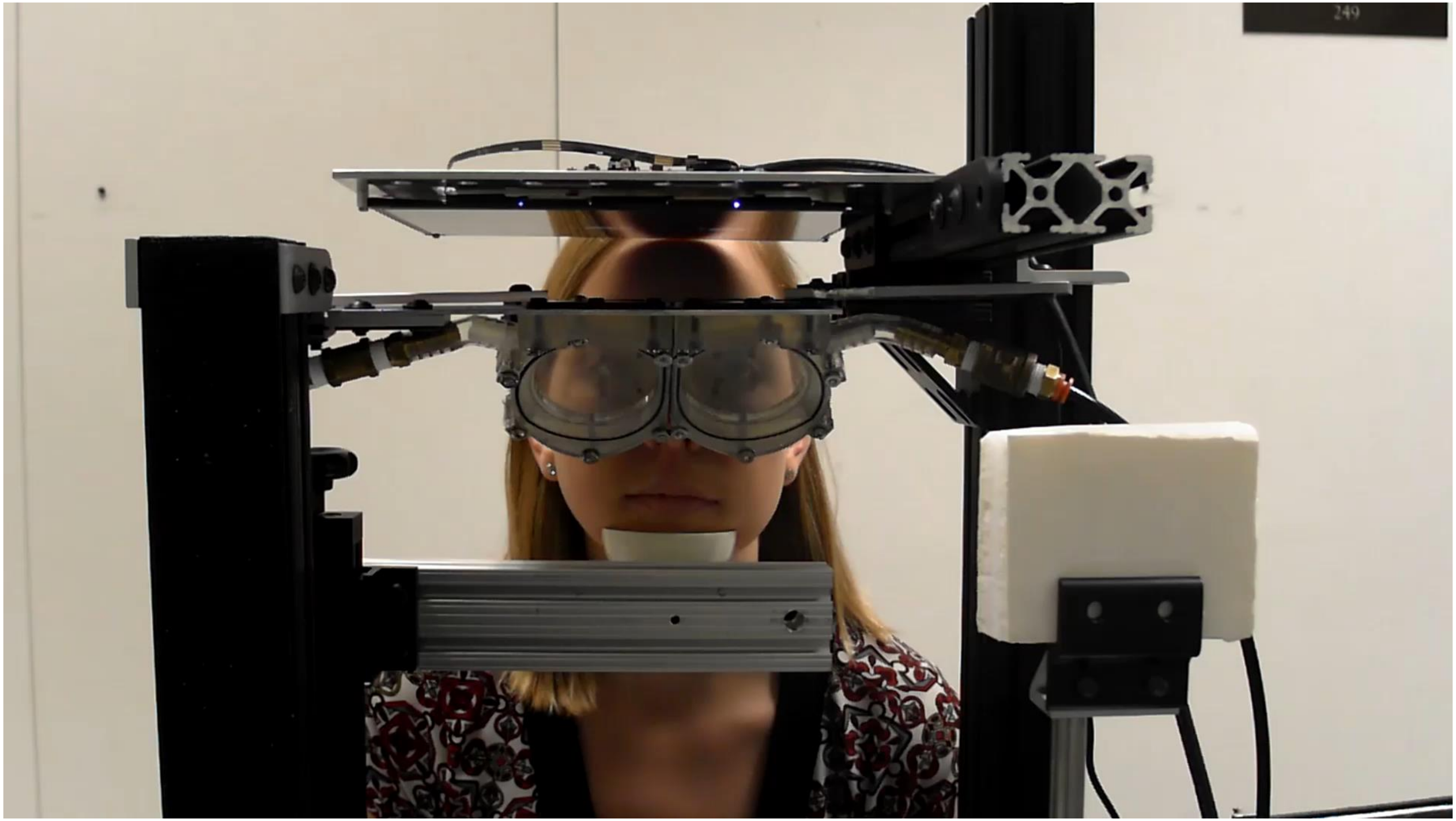


despite the non-linearity of the appearance, it changes monotonically
→ simple residual energy minimization

3D Appearance Printing



Varifocal Displays



Membrane AR – Dunn et al.

Deformable Beamsplitter

Membrane AR – Dunn et al.

Dynamic focal depth: objects at any depth

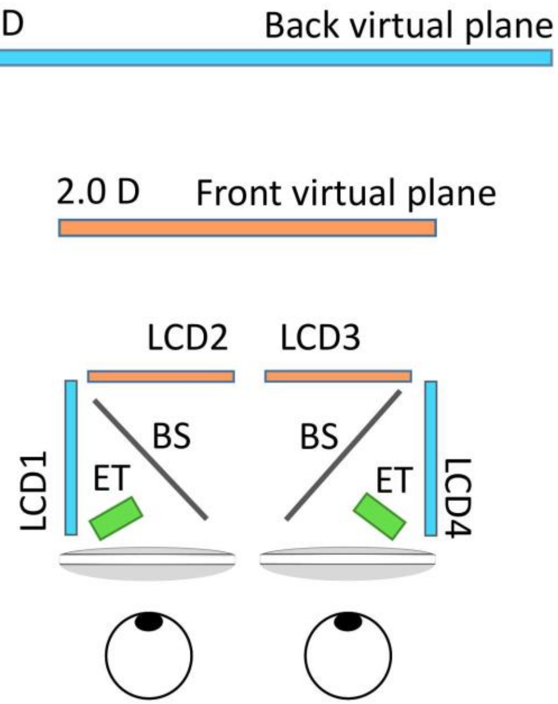
Wide field of view

Optics are simple

Deformable Beamsplitter

Membrane AR – Dunn et al.

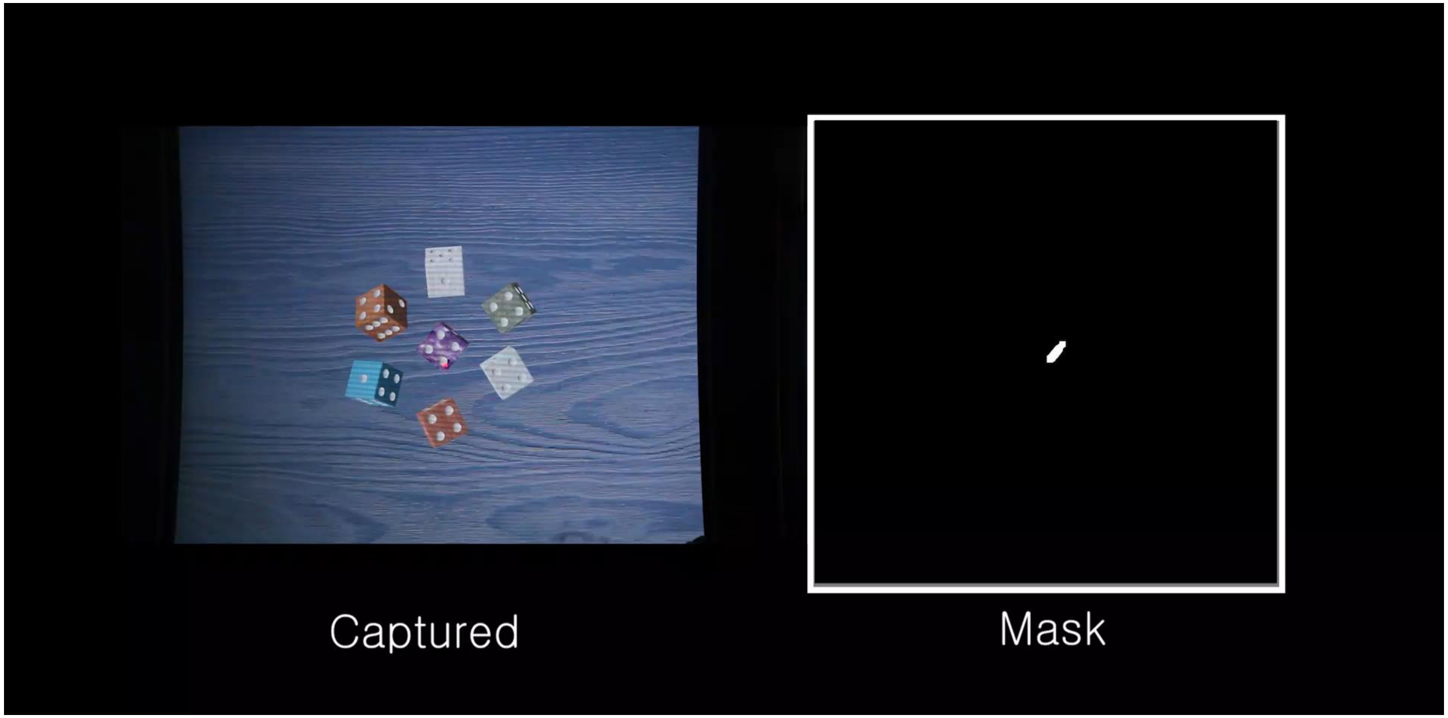
Multi-focal Plane Display



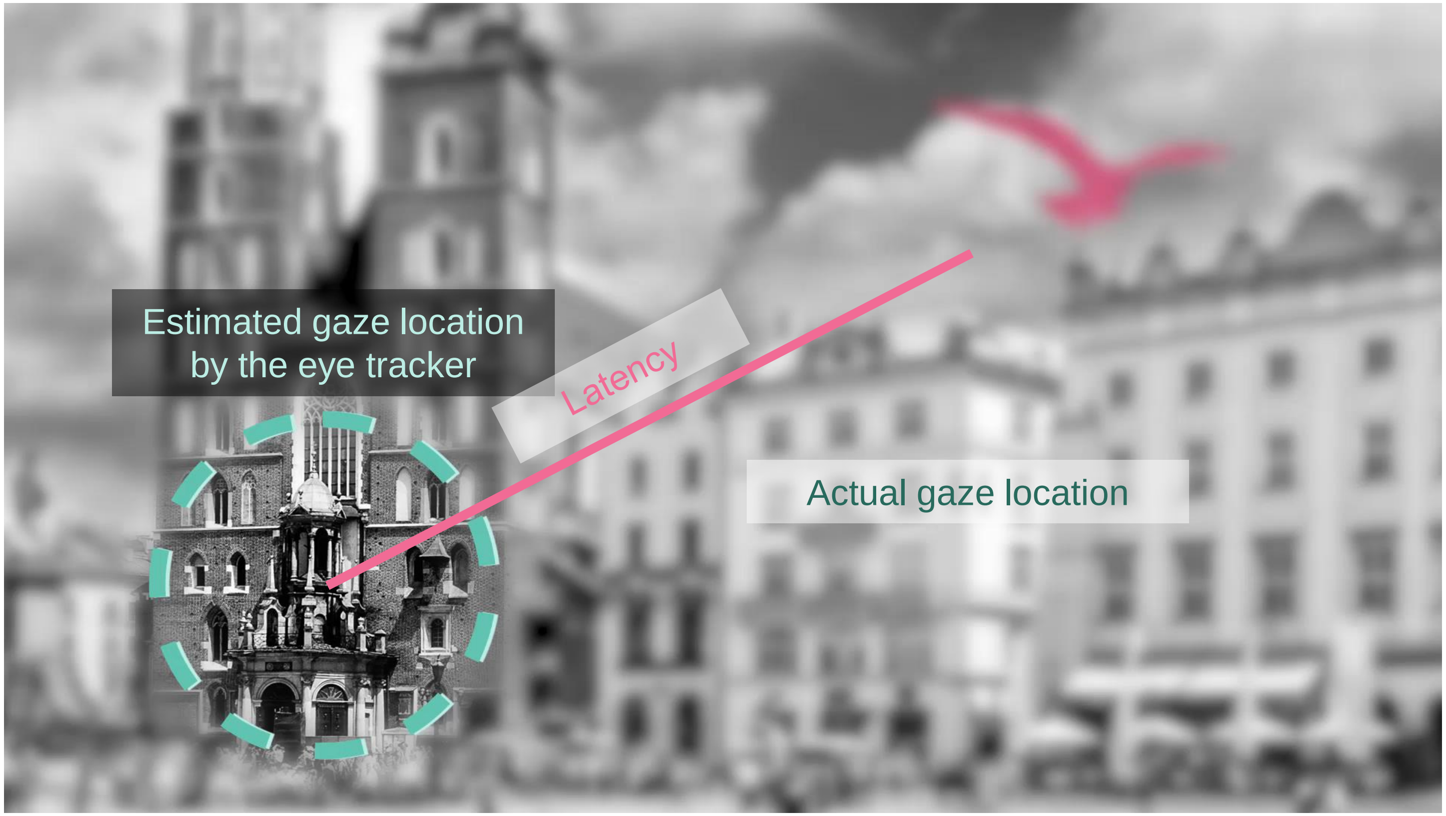
15cpd, 40 deg, 1200x1200 pixels

Multi-focal Plane Display

Temporal coherency

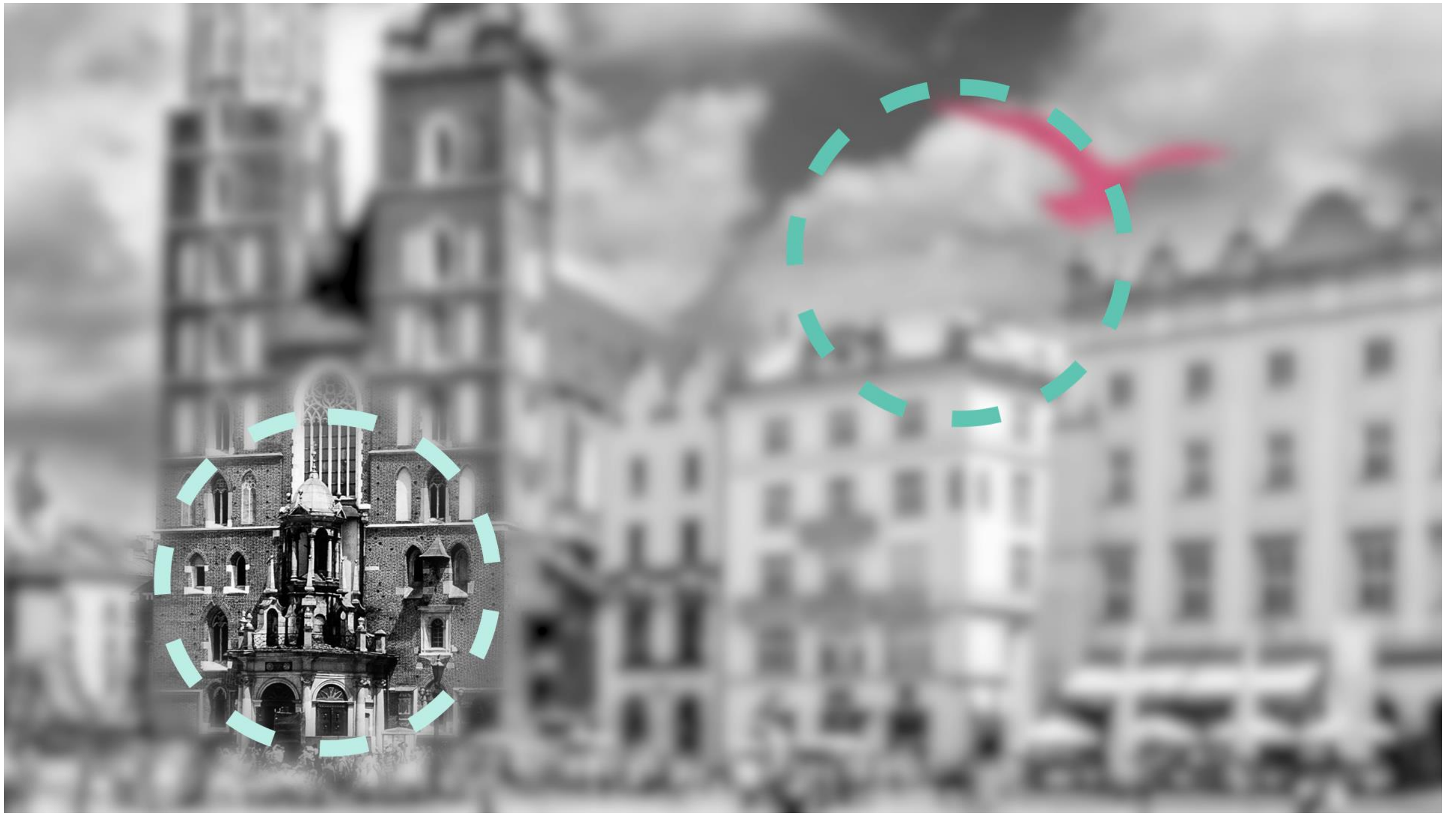


Saccade in Foveated Rendering



Saccade Landing Position Prediction for Gaze-Contingent Rendering

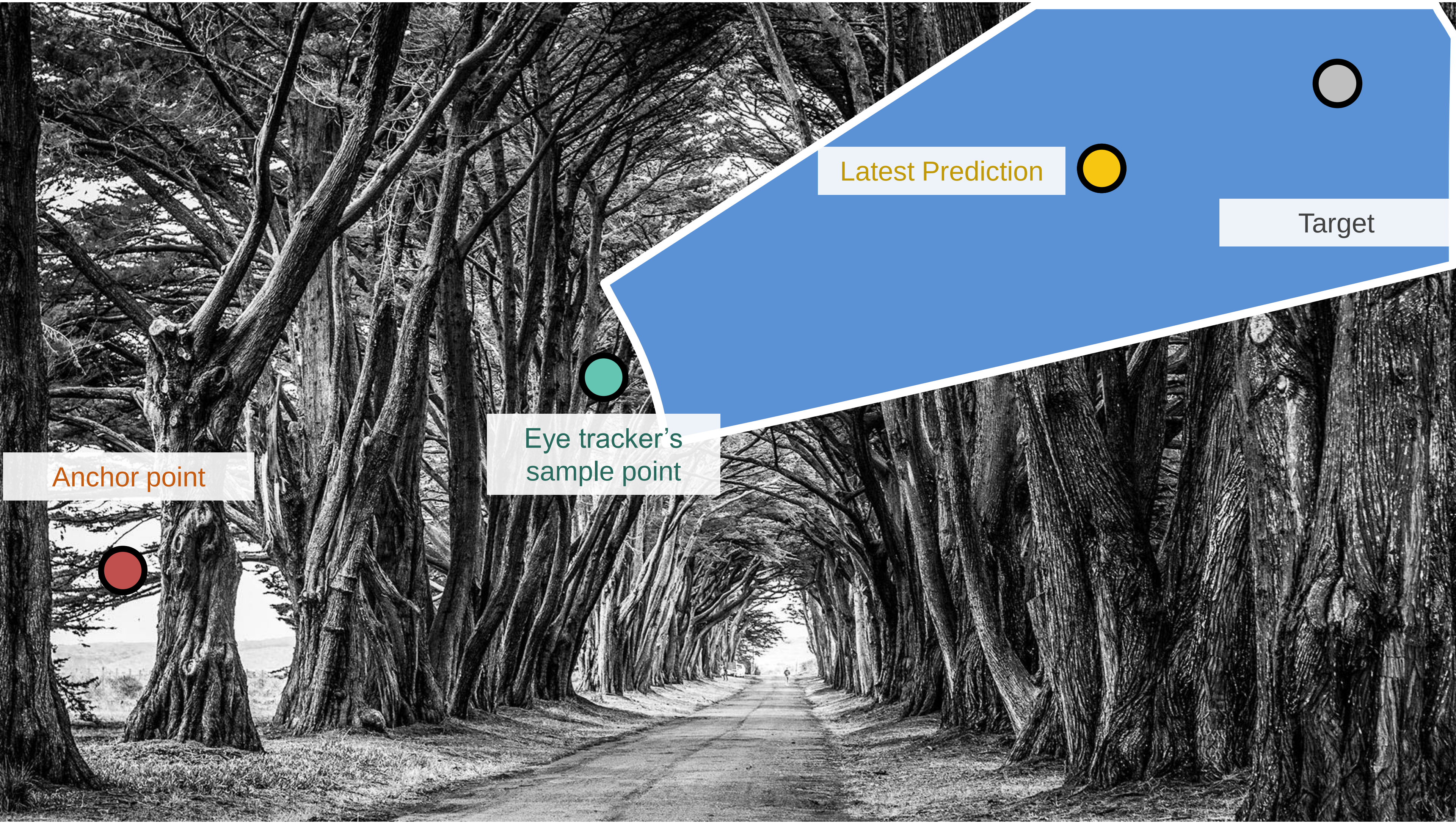
Saccade in Foveated Rendering



Saccade Landing Position Prediction for Gaze-Contingent Rendering

Eye Tracking: Saccade Landing Prediction

Eye Tracking: Saccade Landing Prediction

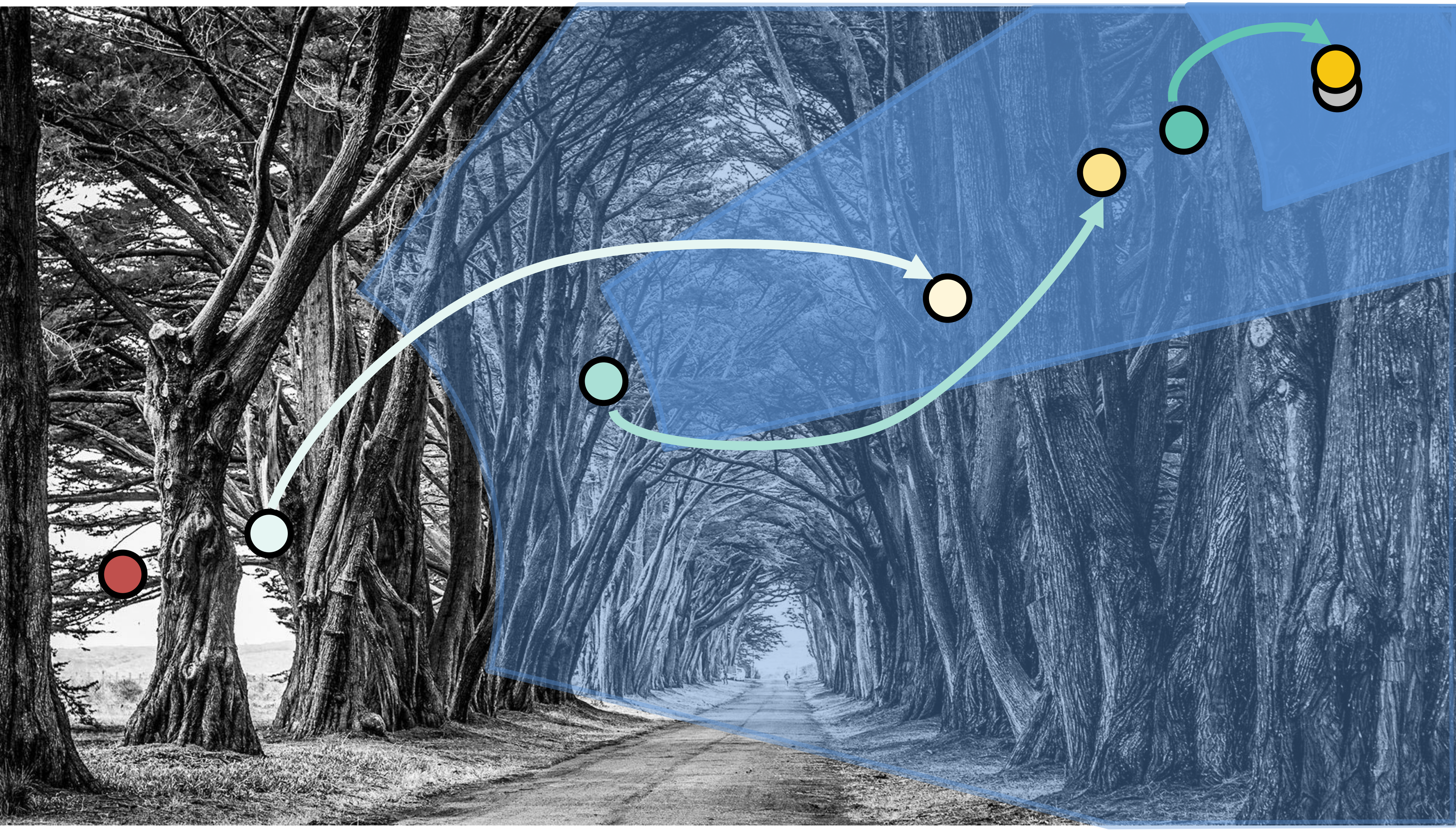


Eye Tracking: Saccade Landing Prediction

Eye Tracking: Saccade Landing Prediction

Eye Tracking: Saccade Landing Prediction

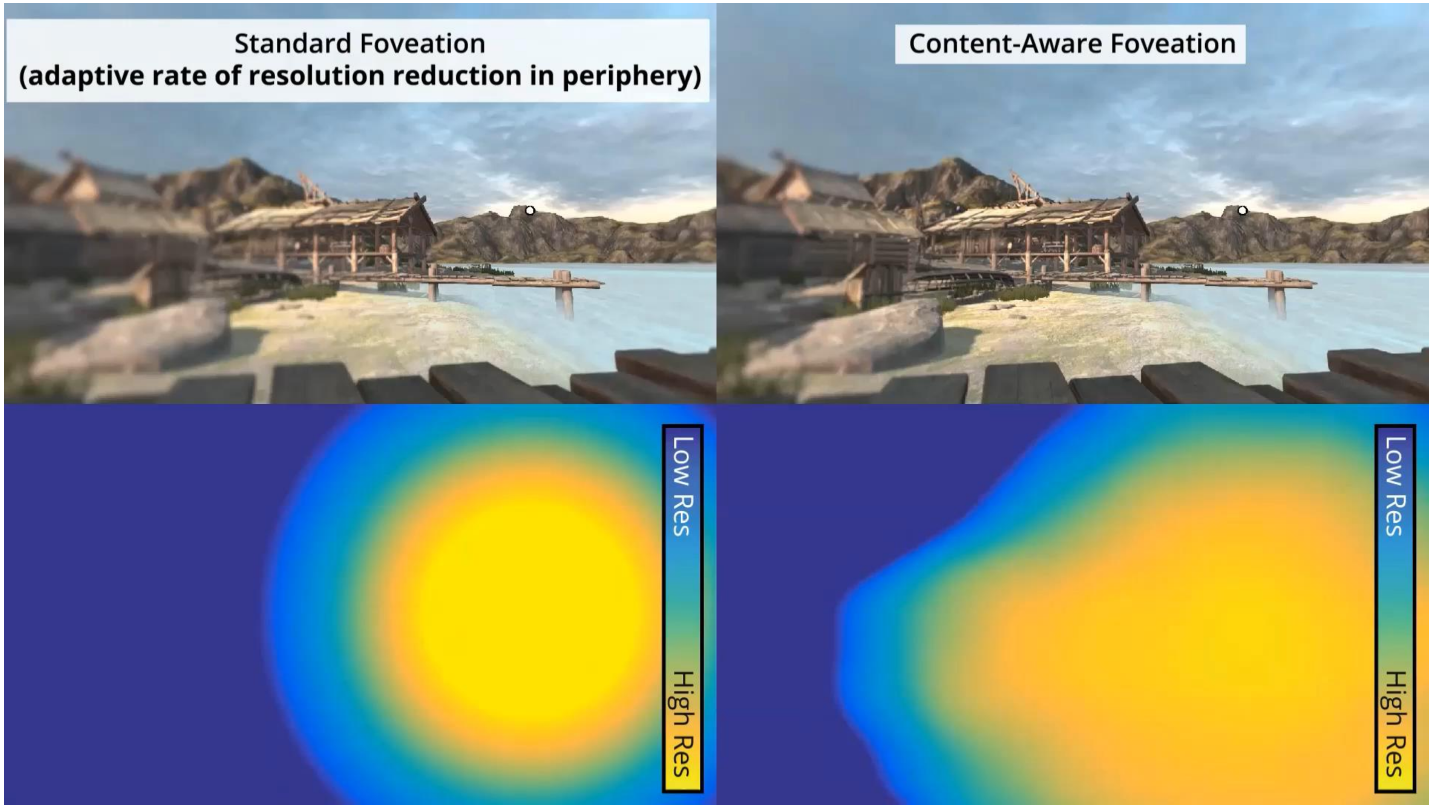
Eye Tracking: Saccade Landing Prediction



Eye Tracking: Saccade Landing Prediction

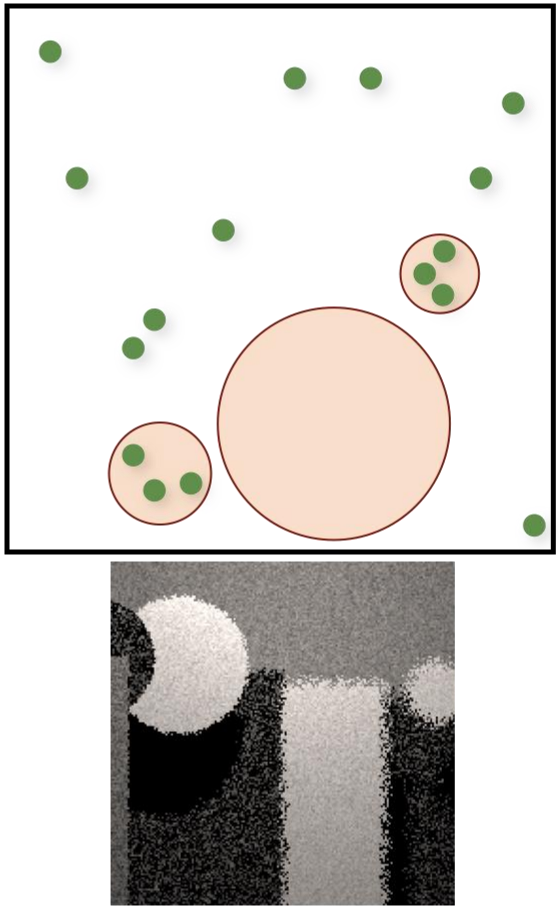
Luminance-Contrast-Aware Foveated Rendering

Luminance-Contrast-Aware Foveated Rendering

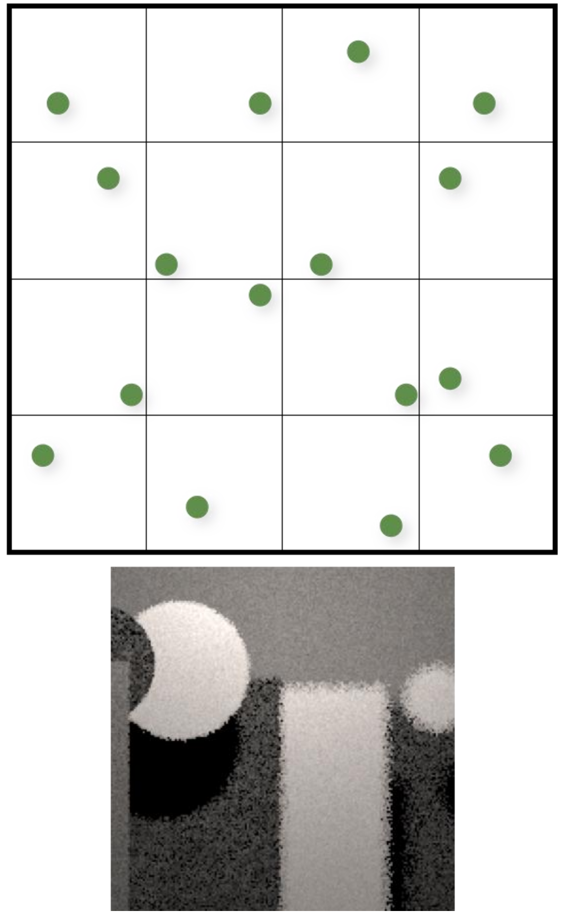


Sampling Patterns

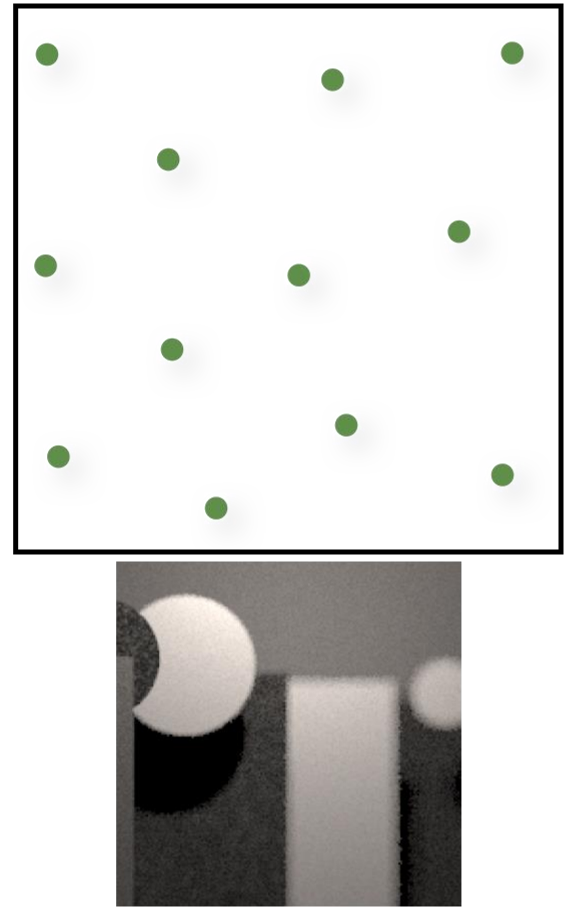
Random



Jitter



Poisson Disk



Advanced Sampling

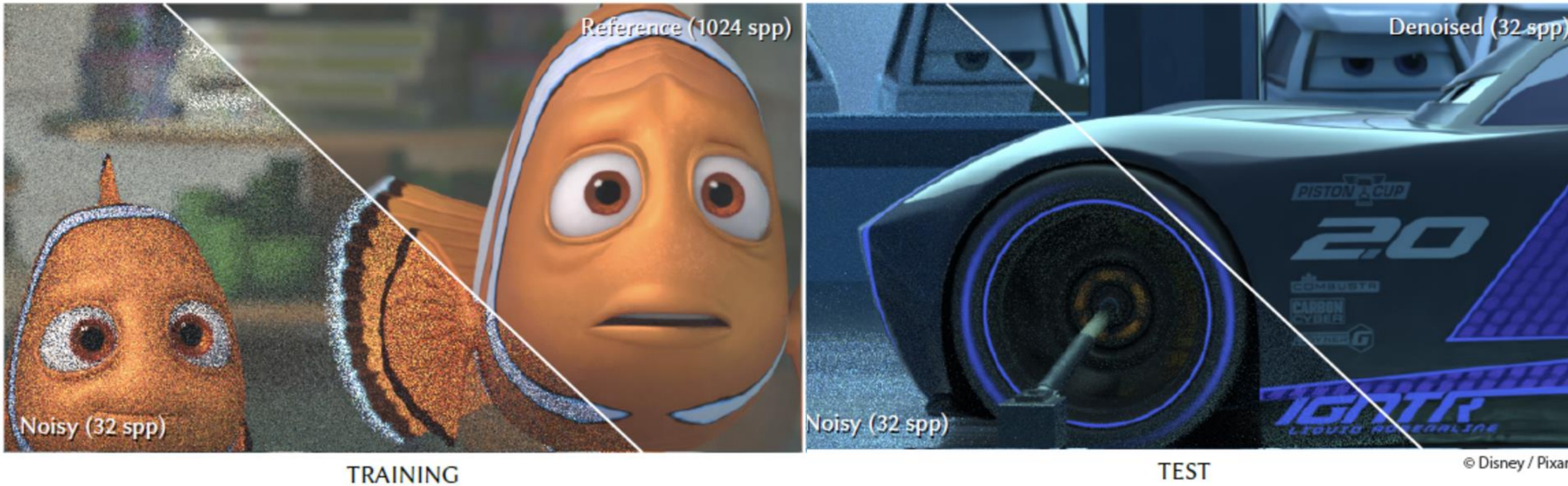
How error in MC integration is affected by different sampling patterns?

Spatial domain statistics: Pair Correlation Function / Discrepancy

Fourier domain statistics

Define Error in terms of Spatial and Fourier domain statistics

Learn to Render: Path to Neural Networks



Bako et al.[2017]

Our Focus: Learn to Render

- ML/NN algorithms for denoising
- CNNs/GANs (unstructured)
- Learning Light Transport the Reinforced Way
- Learning to Importance Sample