



Tone-Mapping Requirements in Real-Time Videos

for studying the dynamism of views-out in virtual reality

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2023 Radiance Workshop

- **LIPID**
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- Supervisors:
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Strengths: Immersive depth perception, 3D vision, environmental control

Limitations: luminance range, resolution, field of view (hardware)

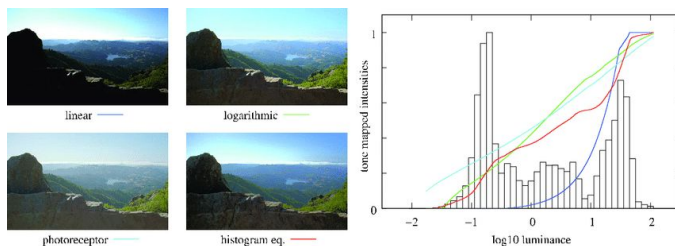


HDR Photos:
Wide luminance range

Tone-Mapping



LDR Display:
Compressed luminance range



Tone-Mapping Operators (TMOs)

Challenges with capturing dynamic movement

Limitations of camera sensors and time required for HDR photography

Incorporating VR without losing temporal dynamics



Canon R5 Camera with
dual fisheye lens

*Ward, 1997; Pattanaik, 2000;
Durand 2002; Reinhard, 2002;
Drago, 2003; Reinhard, 2005;
Mantiuk, 2008; Reinhard02L;
Reinhard 05L*

LDR Output:

Real-time videos, automatically tone-mapped

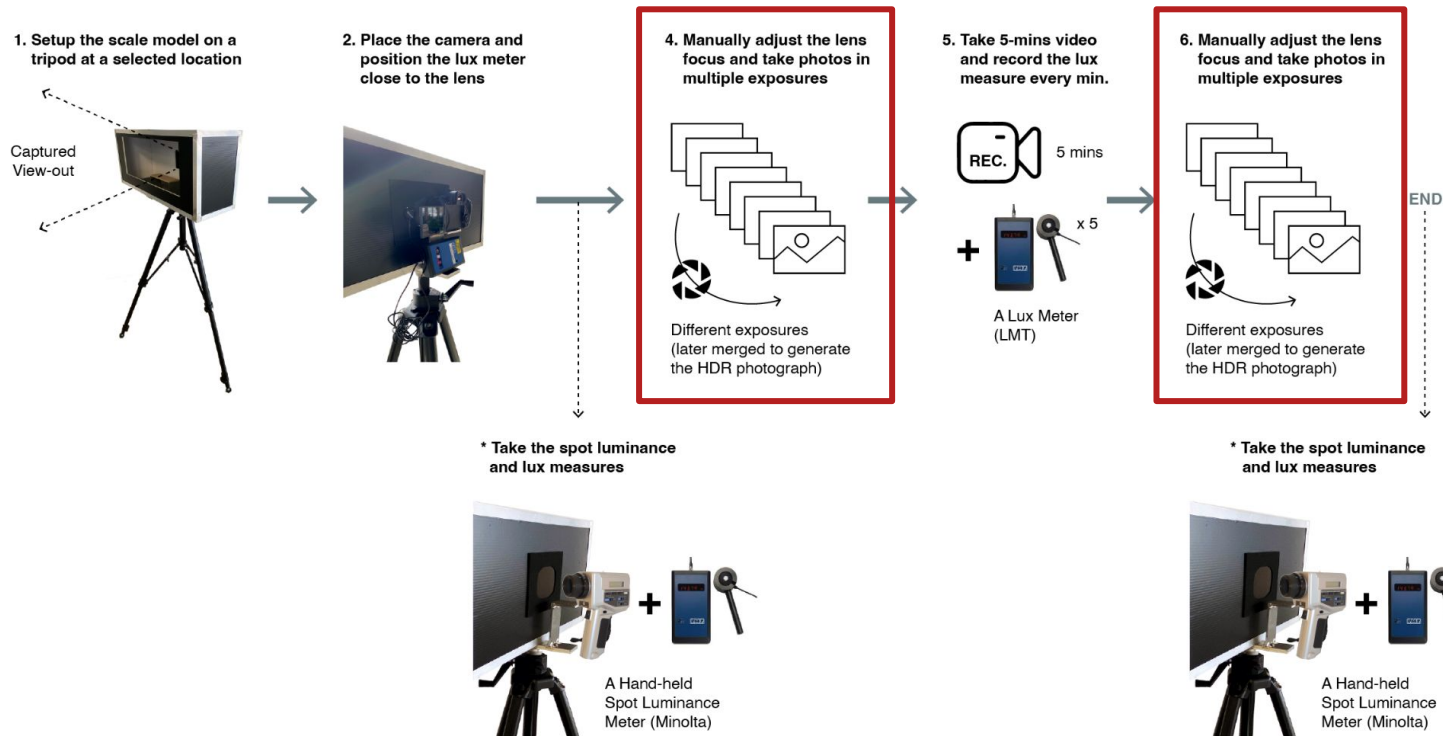
Aim:

Perceptual accuracy **vs.** Technical Feasibility

TMOs (9) vs. camera's built-in VIDEO output:

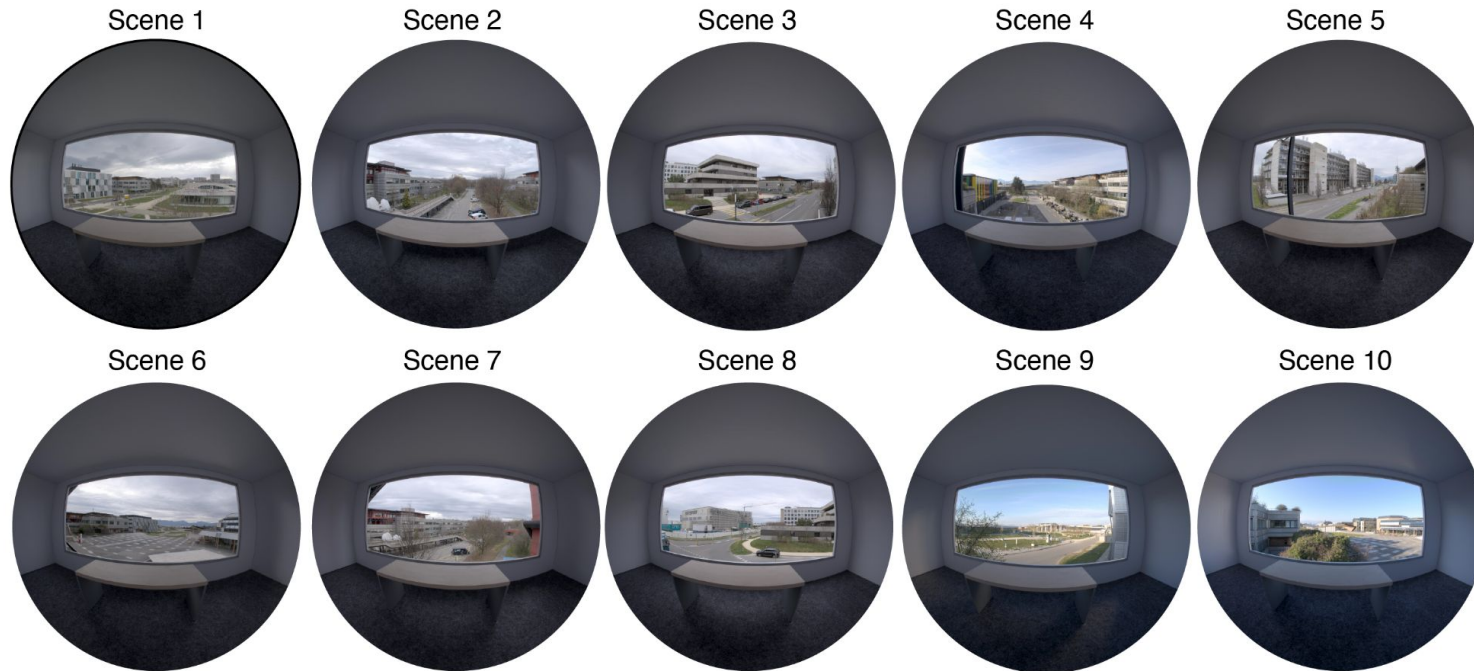
Quantifying differences between real and VR scenes focusing on **brightness and contrast**

HDR - "ground-truth reference"



1. Scene collection method (10 scenes)

*Overcast to clear skies with no direct sun entering the FoV / model: 2,400 - 36,000 cd/m²

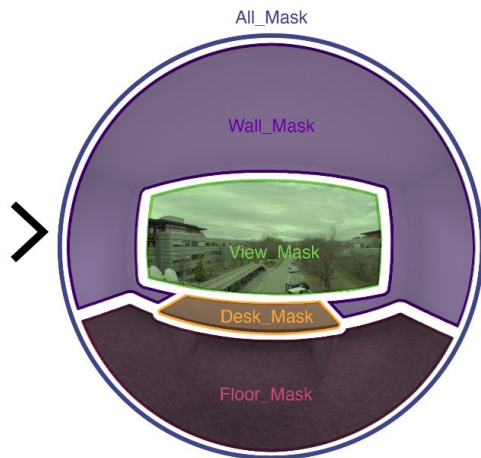


COMPONENTS OF THE COMPARATIVE ANALYSIS

(A) **Cropped Fisheye Image** - Original

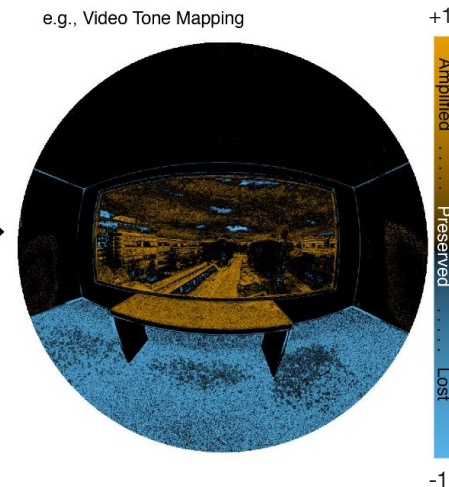


(B) **Masked** - All, Wall, View, Desk, Floor



(C) **Analyzed** - Contrast Amplification and Loss

e.g., Video Tone Mapping



CIVDM:

*Compared to HDR image displayed on an ideal HDR output device

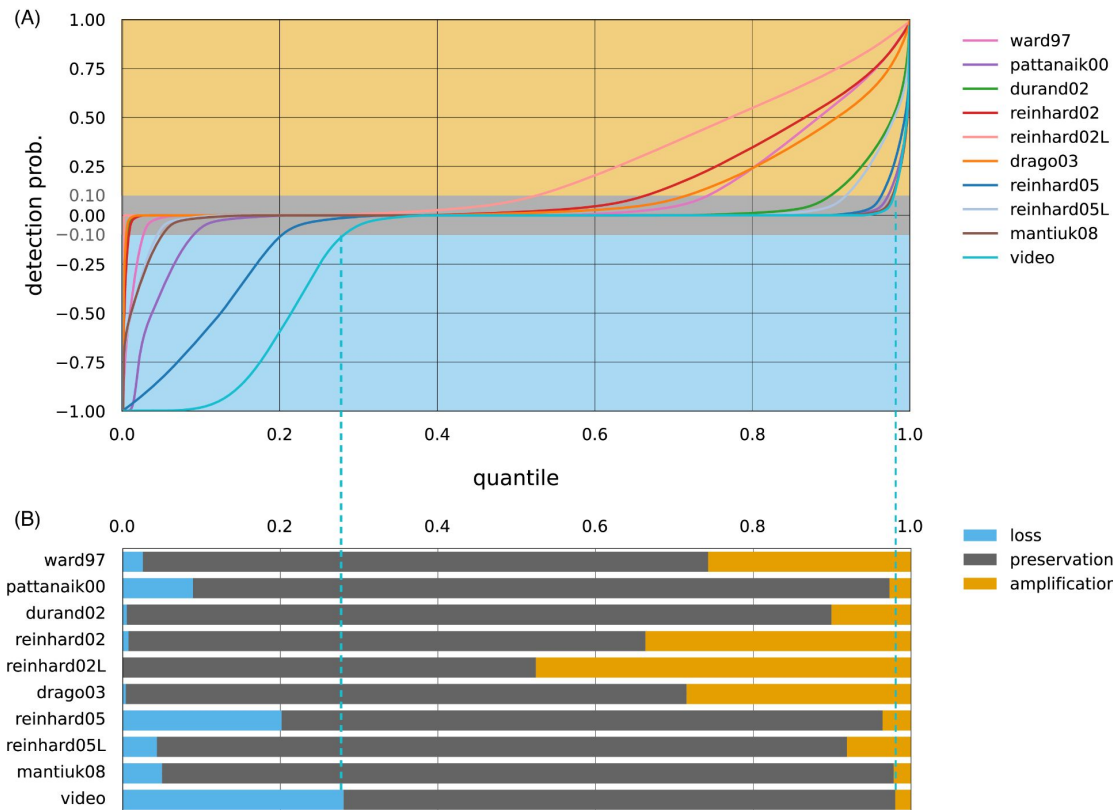
(per-pixel basis)

* Pico Neo Pro 3 Eye VR Headset was used.

* CIVDM (Aydin et al., 2008)

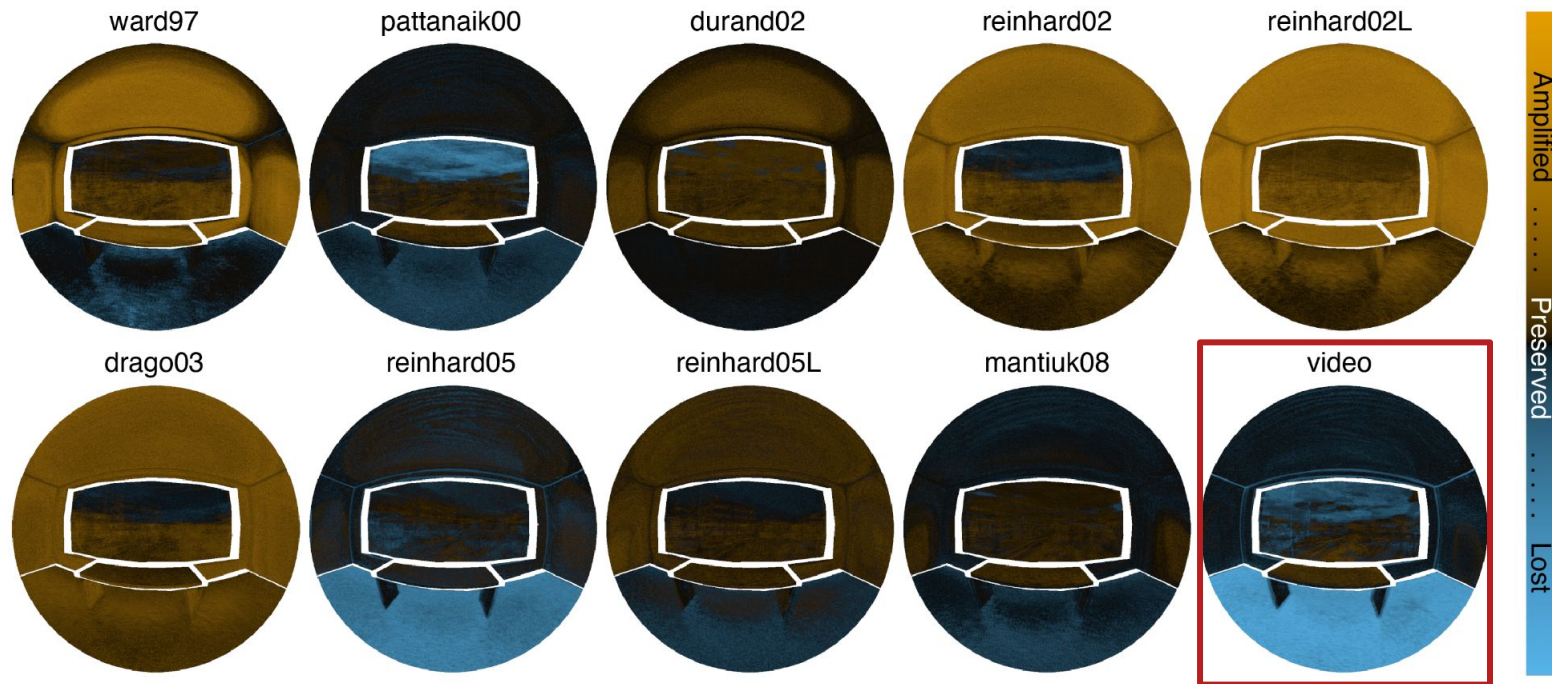
3. Results: Analysis on the Entire Image

COMPARATIVE ANALYSIS FOR AN ENTIRE IMAGE AREA (All_Mask)

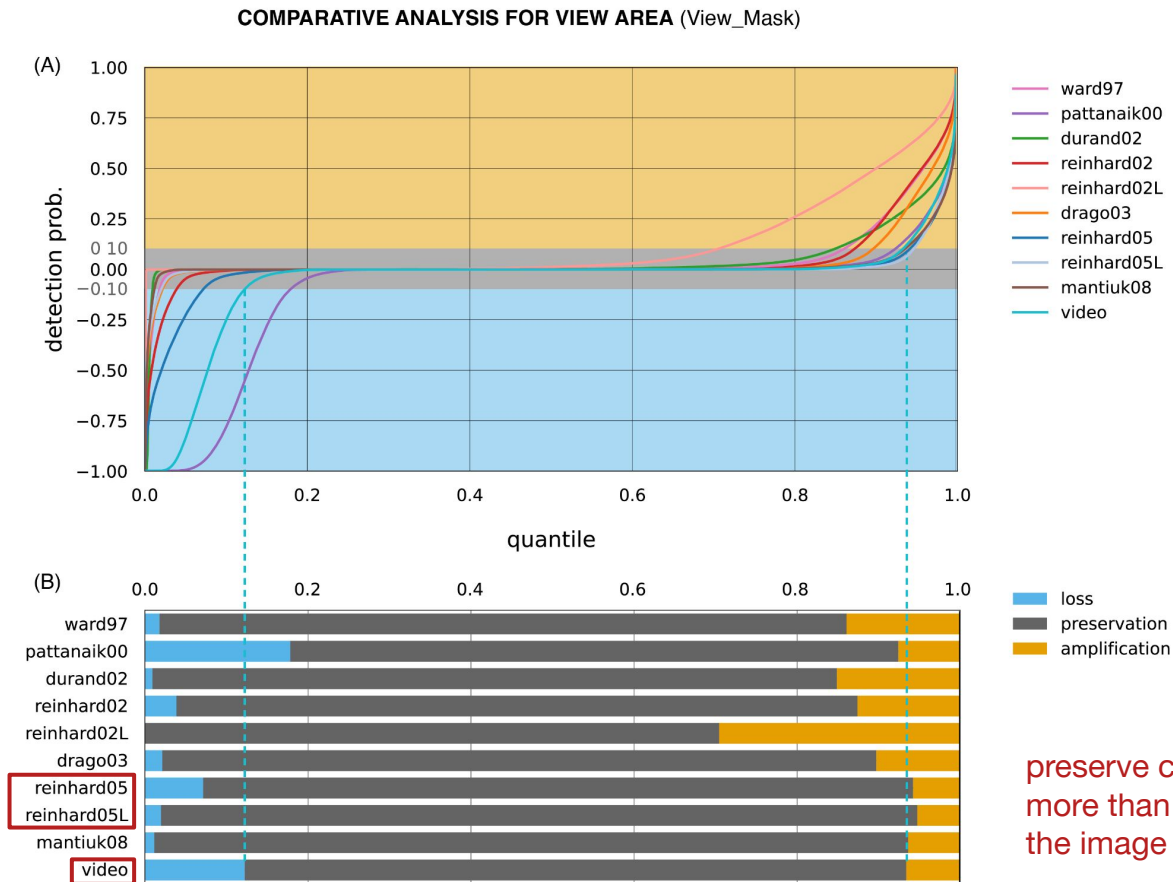


- **Min. loss:**
Ward97,
Reinhard02L,
Drago03
- **Min. amplification:**
Video,
Reinhard05,
Pattanaik00
- **Balanced:** (<10%)
Durand02,
Reinhard05L,
Mantiuk08

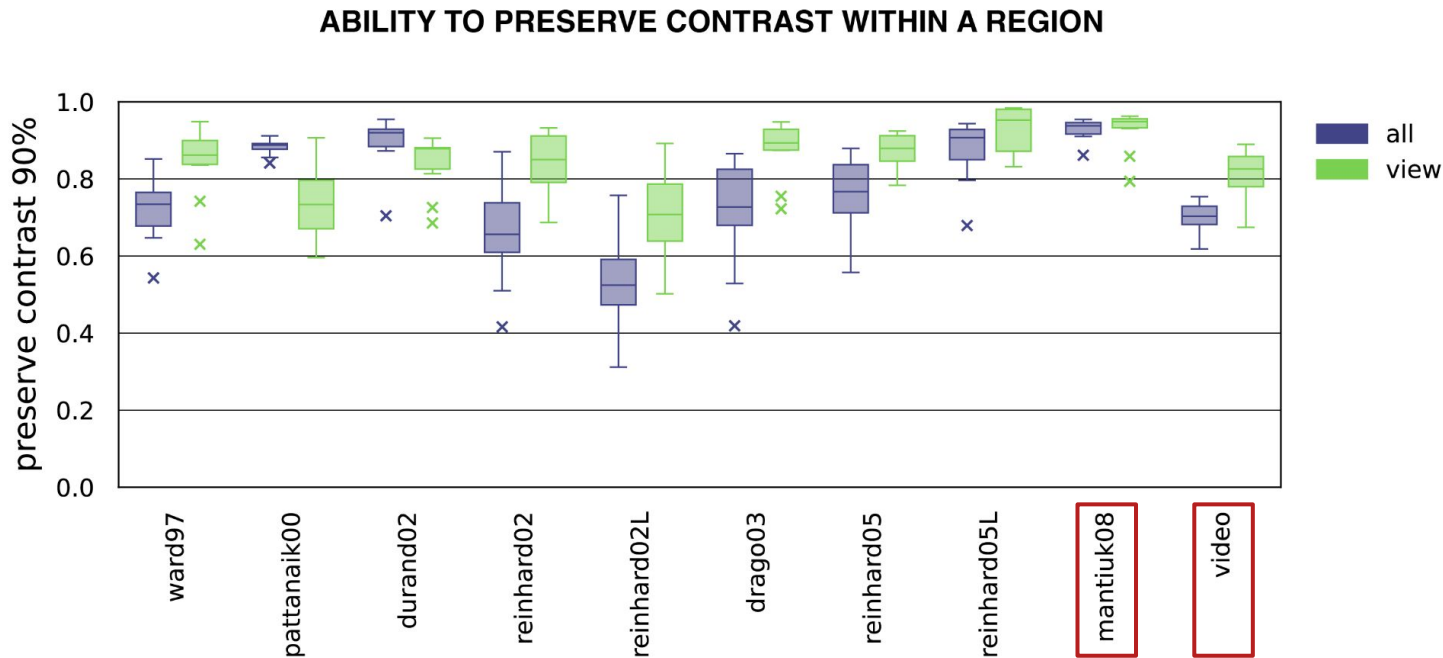
4. Results: Contrast Issues



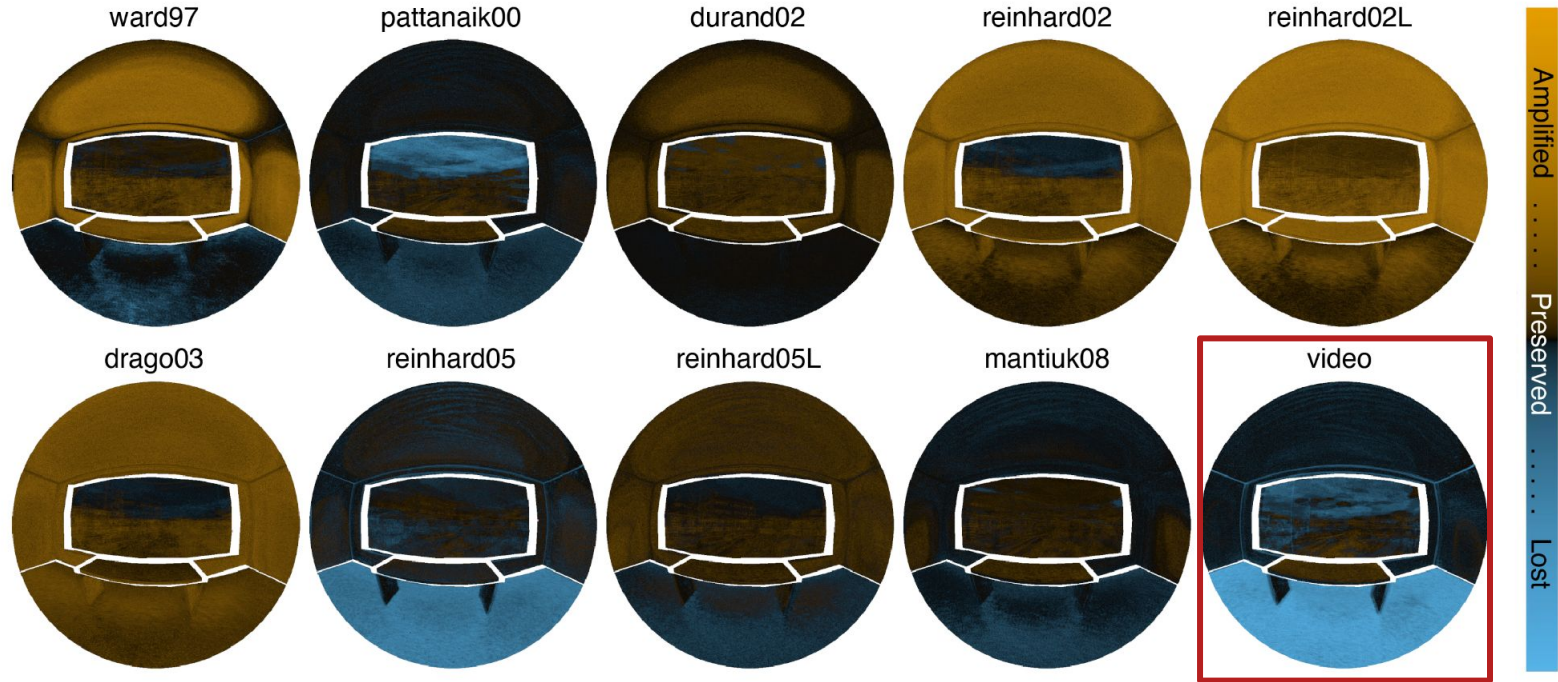
5. Results: Analysis on the View Area



6. Discussion: Summary of the Results



7. Discussion: Limitations of VR Display

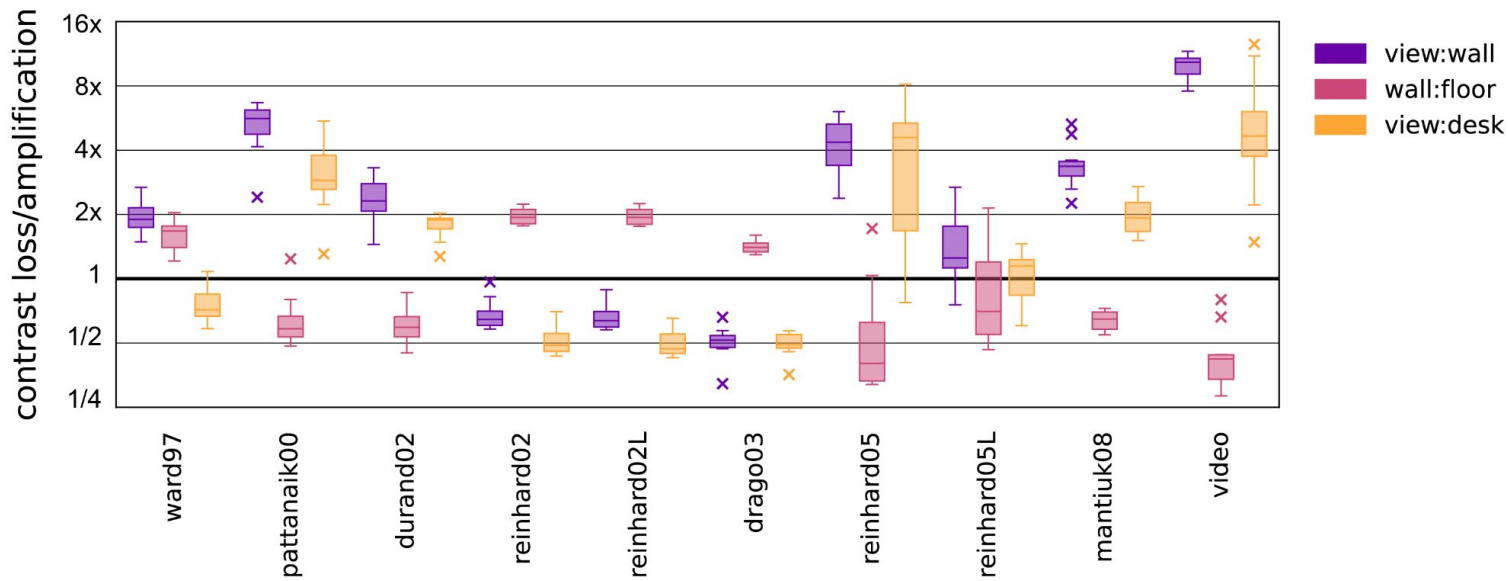


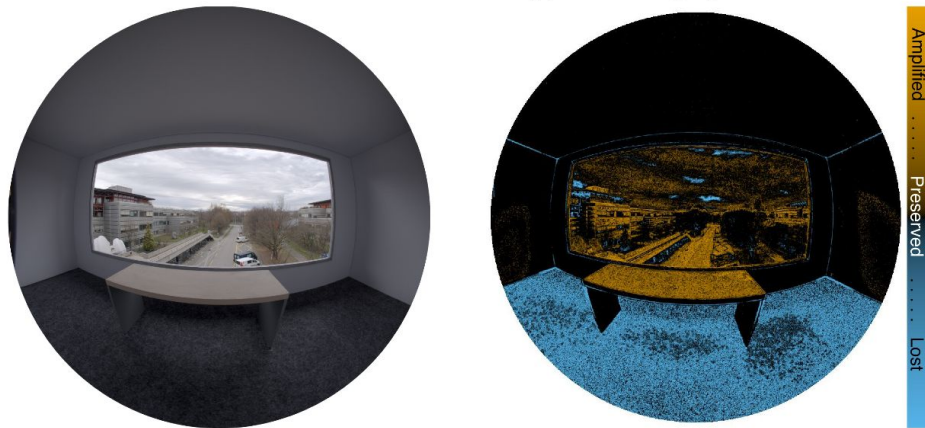
7. Discussion: Limitations of VR Display

VR Headset: 0.2 - 86 cd/m² (430:1)

... Scenes: 320:1 - 7700:1 (median: 1200:1)

ABILITY TO PRESERVE CONTRAST ACROSS REGIONS

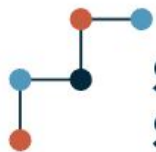




- Effectiveness of camera's automatic tone-mapping
- CIVDM (Contrast Invariant Difference Metric) as valuable tools
- Further testing with diverse scenes, devices, and outputs.

Further details on the study can be found in the upcoming [CIE Conference Proceeding](#)

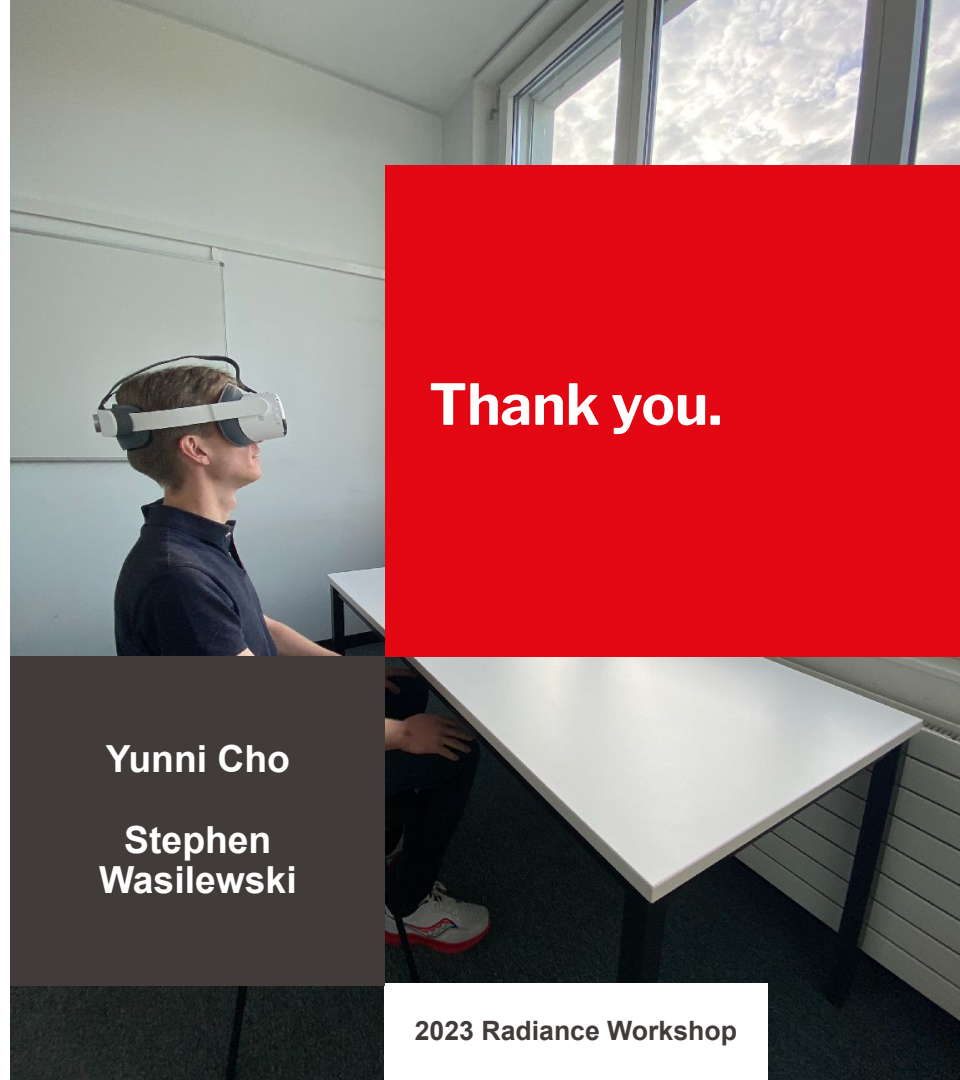
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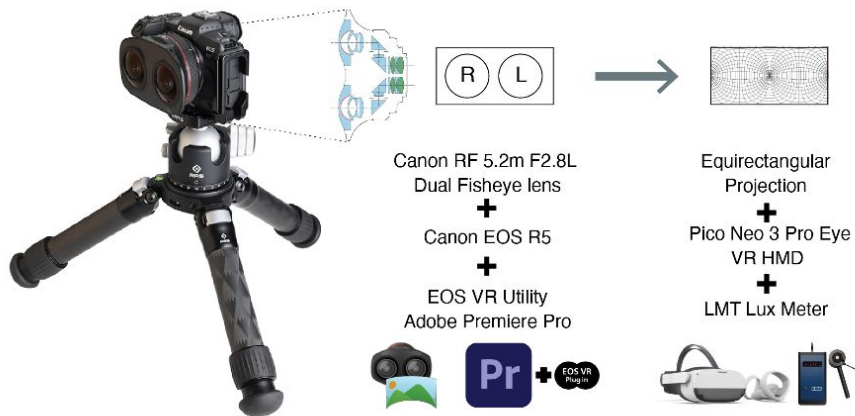
Thank you.

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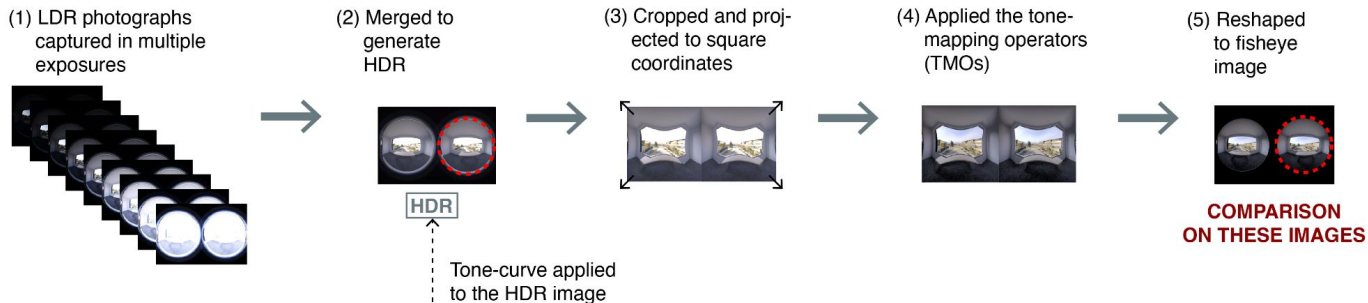
Supplementary Slides



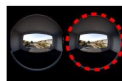
(1) Real-time Videos captured using
Canon EOS R5 and dual fisheye lens

(2) Scale model of an office room





(1) The first image frame from an LDR video (using the camera's automatic settings)



(2) VIDEO TONE CURVE RECOVERY

