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FIIF Event with AI for Situational Awareness (AISA) project:

Ultra Realistic Real-Time Rendering for the Industrial Metaverse

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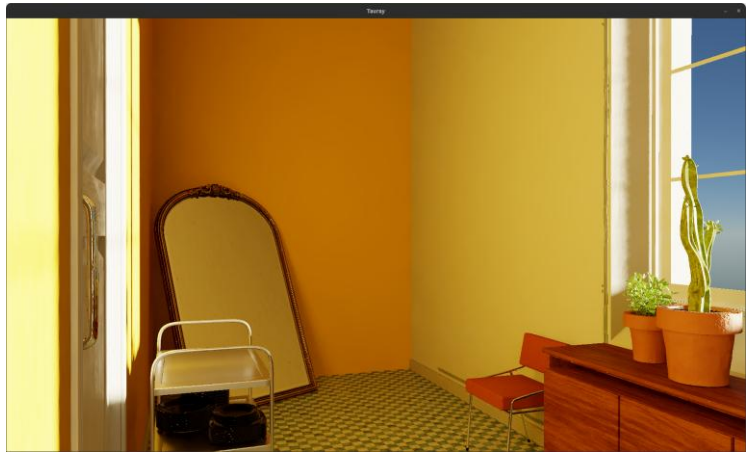
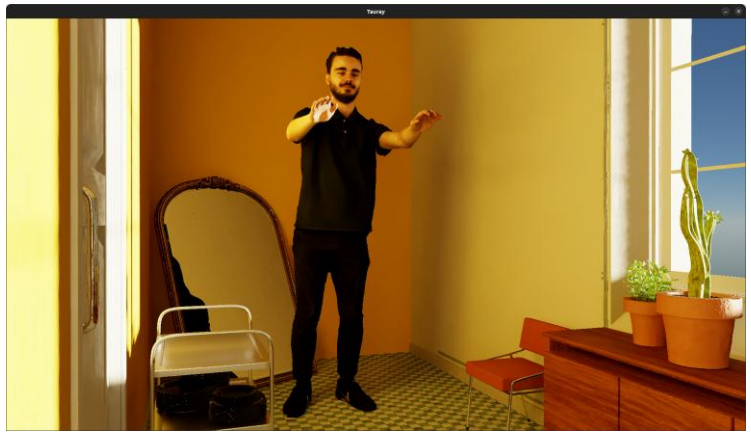
In Finnish Industrial Internet Forum’s (FIIF) Event with AISA Project: AI for Situational Awareness (Nov 21, 2024, Tampere and online)

Digital Twinning

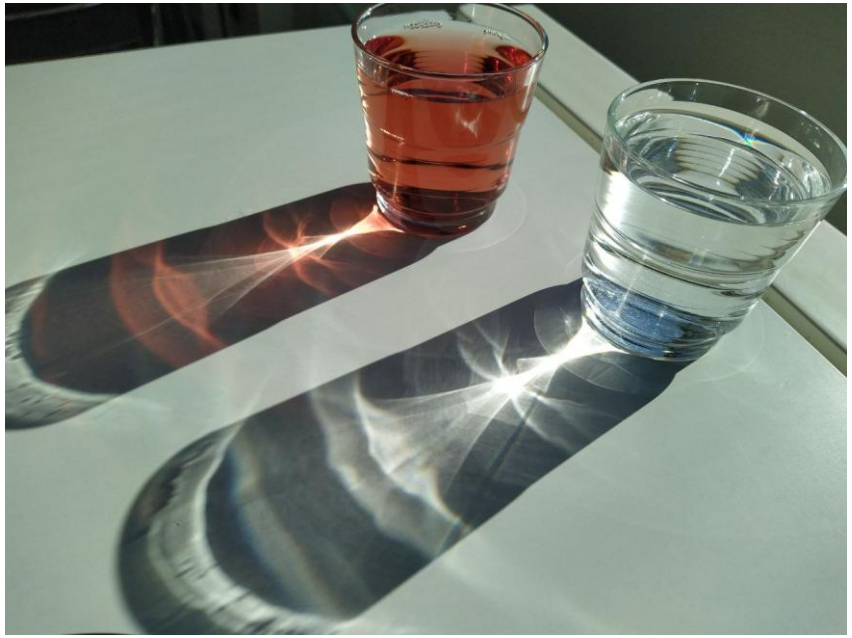
- Creating a virtual copy of a real person, environment, or product
- Factory simulation, product/process design, manufacturing, telepresence, training people or autonomous machines to operate in challenging/hazardous conditions, urban planning, virtual clinical trials…
- Immersive metaverse with augmented virtual data from various sensors

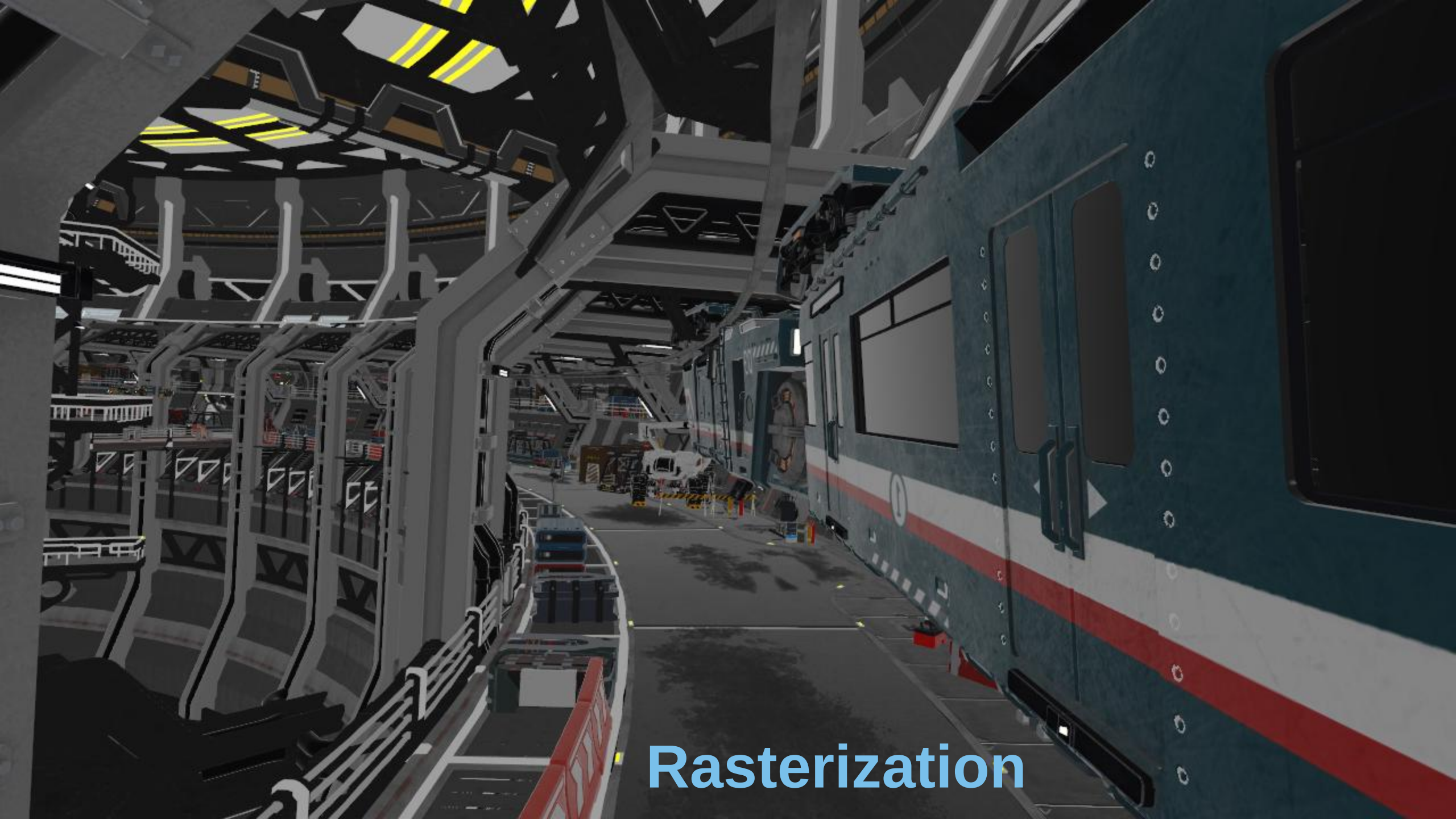




Why Photorealism Matters

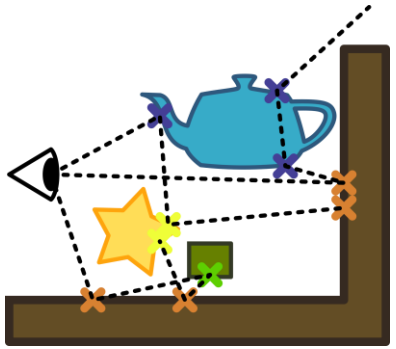
- More **accurate depiction of the real world** than achievable with rasterization-based techniques
  - Models how light actually behaves
  - Realistic reflections, shadows, and indirect lighting
- Enables an **immersive metaverse** experience
- Photorealistic training data yields **better results for AI**



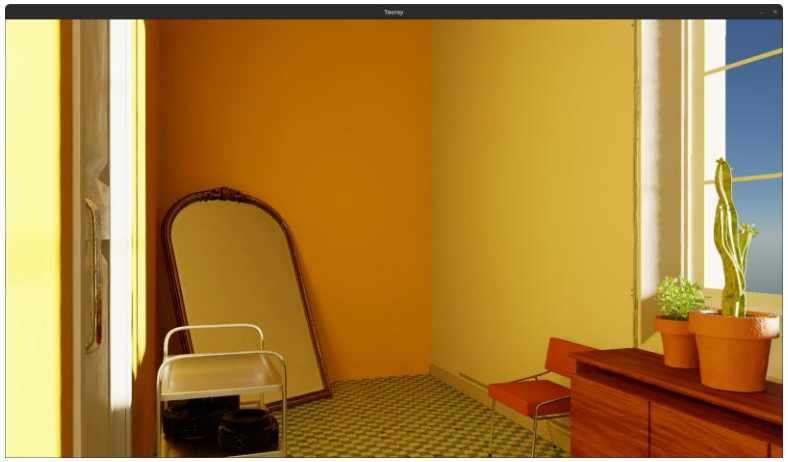

Rasterization


Physically-based rendering

Challenges



- Photorealistic rendering is computationally very heavy
- Either produces noisy real-time data (**path tracing**), or requires lengthy training/preprocessing (**NERFs, Gaussian splatting**)
- Low latency and high framerates are essential, especially for immersive metaverse applications
  - Multi-view XR applications require much more pixels to be rendered



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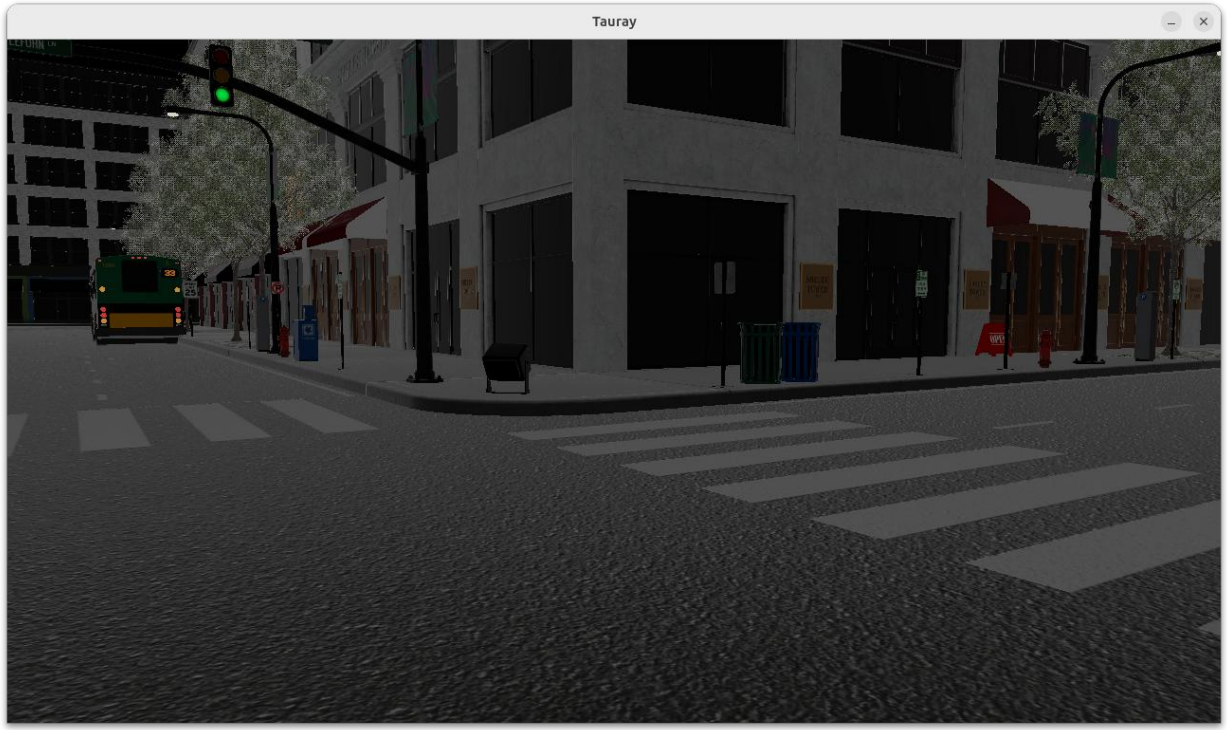
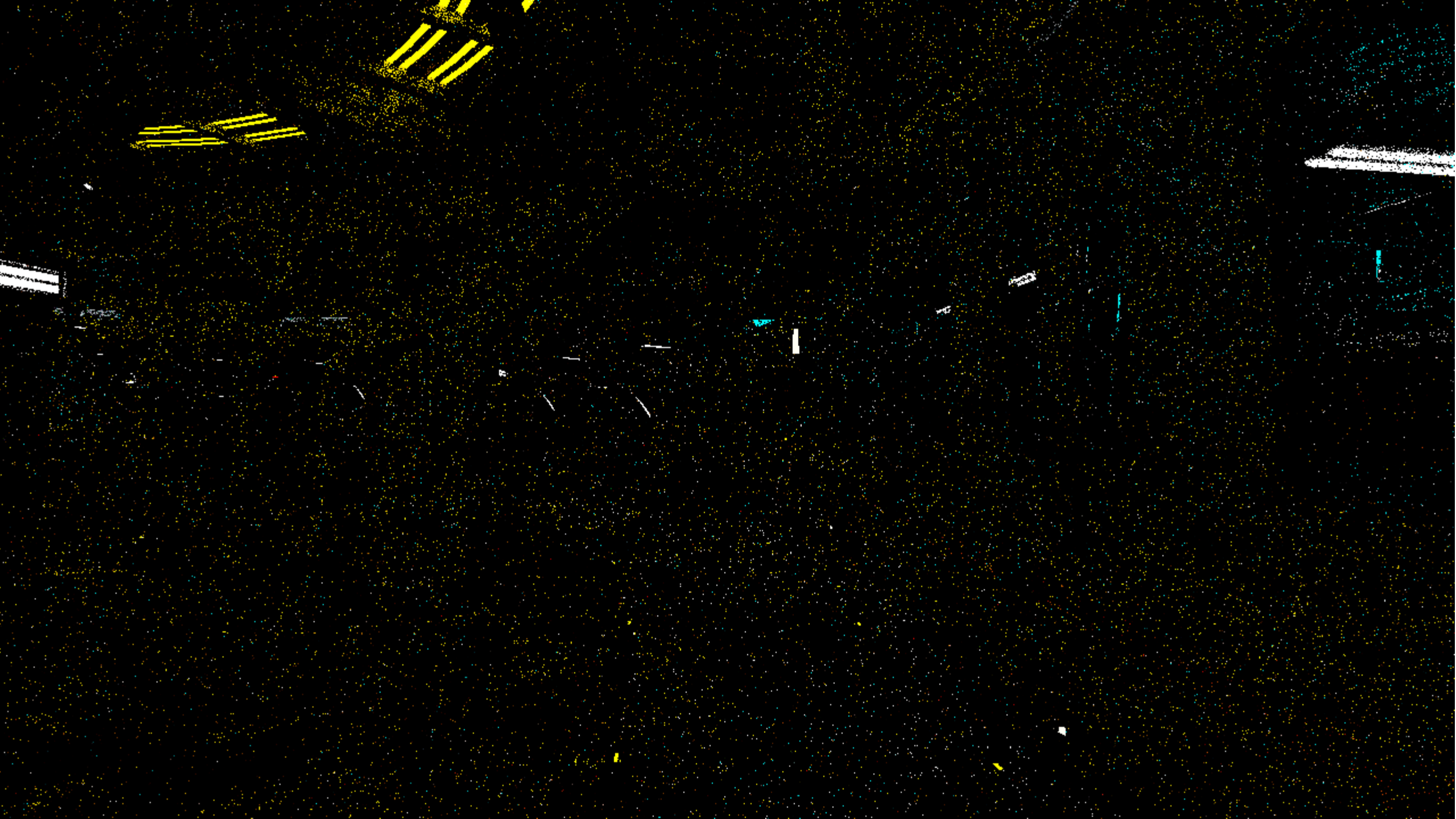
Rasterization



Path Tracing



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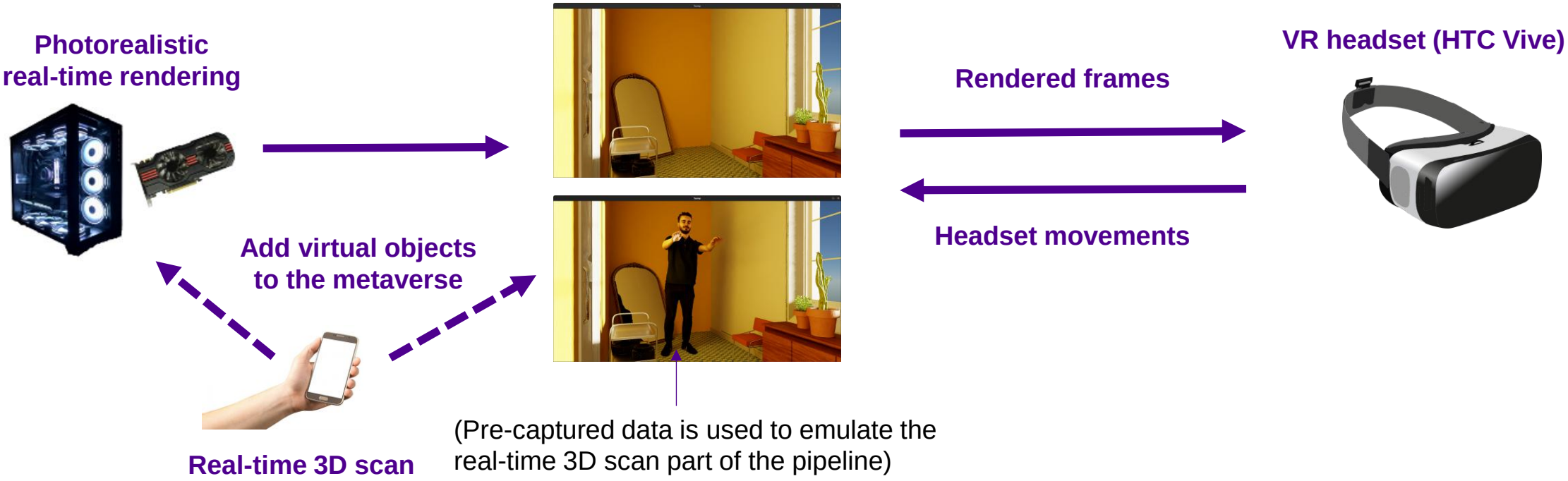
Demo: Photorealistic VR Rendering for Real-Time Digital Twins

- **Real-time photorealistic VR rendering** of a challenging virtual environment
- Integration of a 3D-scanned dynamic **digital twin**
  - **A moving person** from the **UVG-VPC** dataset
- **Dynamic lighting** (you can operate a flashlight with the headset controller)



Tauray: Photorealistic VR

- Tauray is an open-source research renderer by our group
- **Real-time global illumination** using path tracing, **ReSTIR-PT**, hybrid techniques, and denoising
  - Accurate **reflections** and **indirect light**
- **3D scan stream** support (in the demo: digital twin of a person)
- Supports **multi-GPU** and **edge-offloaded** rendering
- Supports **VR** and **light field rendering** through OpenXR
- **Tauray 2.0** just released: github.com/vga-group/tauray

Future Directions

- Distributed multi-server edge offloading
- Volumetric rendering
- Going from room-scale to Metaverse-scale with a large number of simultaneous XR users
  - Many of our techniques are already independent of the viewport count and user count
  - Distributing ReSTIR is a major challenge

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Thank You!

Our Tauray renderer:
github.com/vga-group/tauray
(Tags → v2.0.0)

Our publications:
tuni.fi/vga

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