KIDELTA
LEARNING
Scalable AI for Automated Driving

Final Event | March 10, 2023

SceneNeRF:
3D Reconstruction of Real-World Scenes

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Motivation

- Synthetic data samples as well as entire simulators play an increasingly important role
  - Training and testing of visual perception models
  - Reinforcement learning of driving policies
- Transferability of the results in the simulation to the real world is bounded by the simulation's realism
  - Especially due to the lack of diverse environments

<u>Goal</u>

Increase the availability of diverse virtual worlds

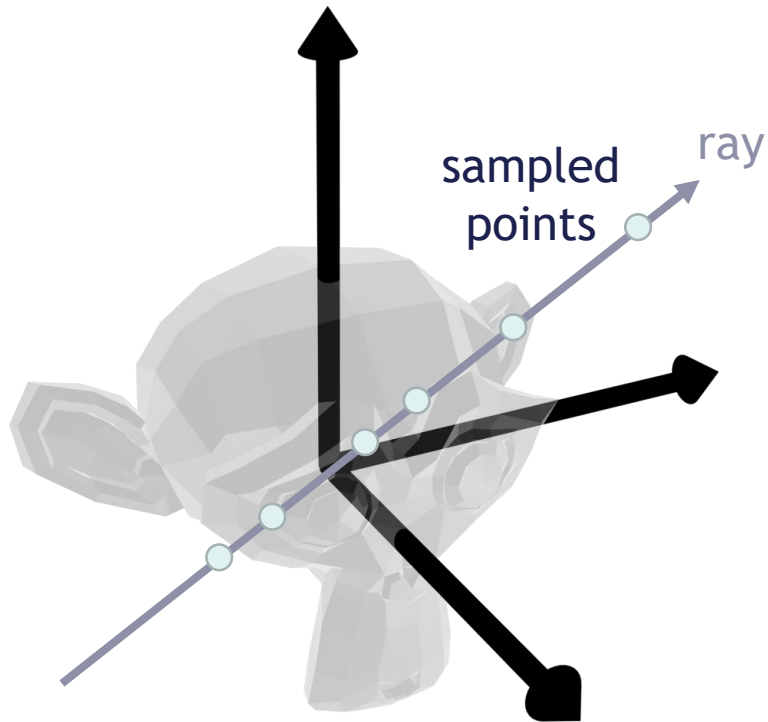*by 3D reconstruction of real-world scenes.*
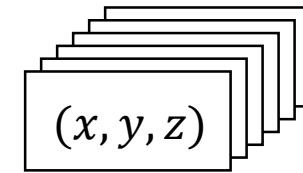
Related Work
Neural Radiance Field (NeRF)
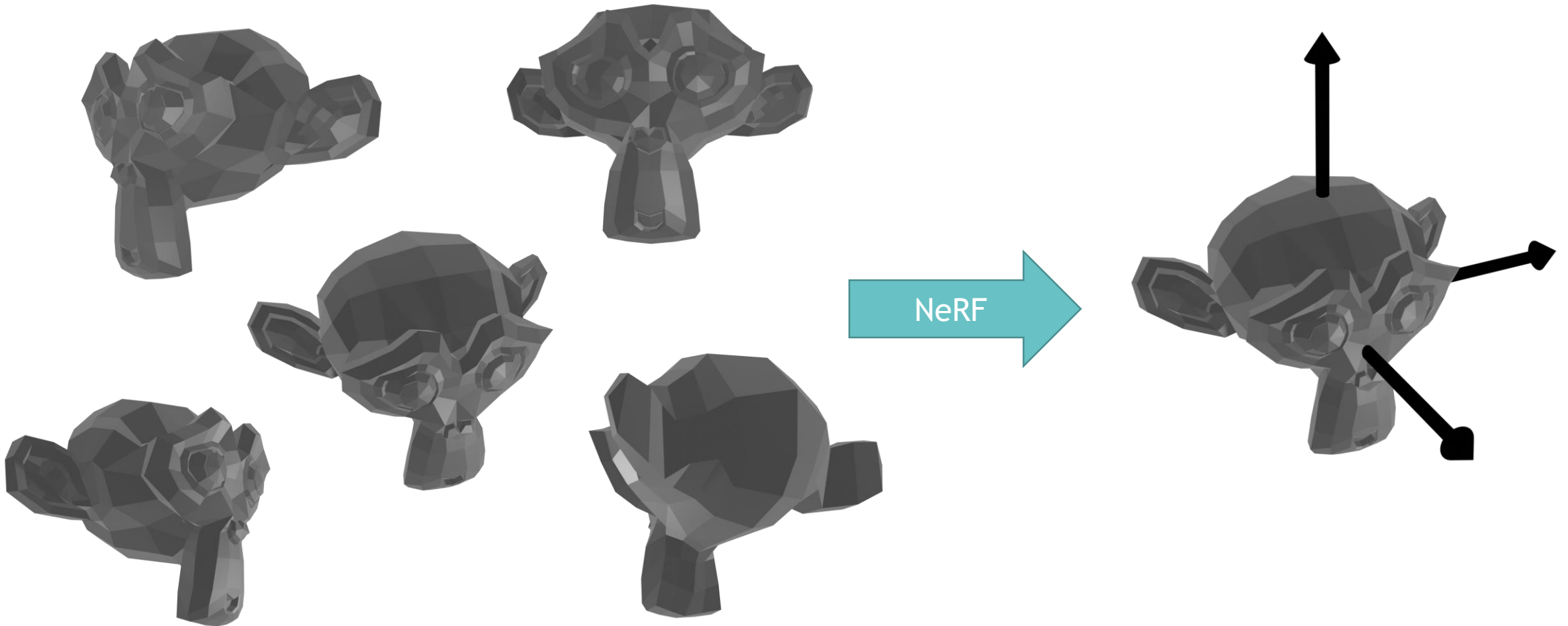
NeRF

Related Work
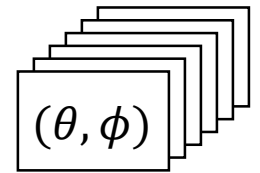## Neural Radiance Field (NeRF)

sampled
points

ray

sample points
along a ray

the rays are
determined by the
camera positions and
viewing directions of
the input images

(x, y, z)

points

$+$
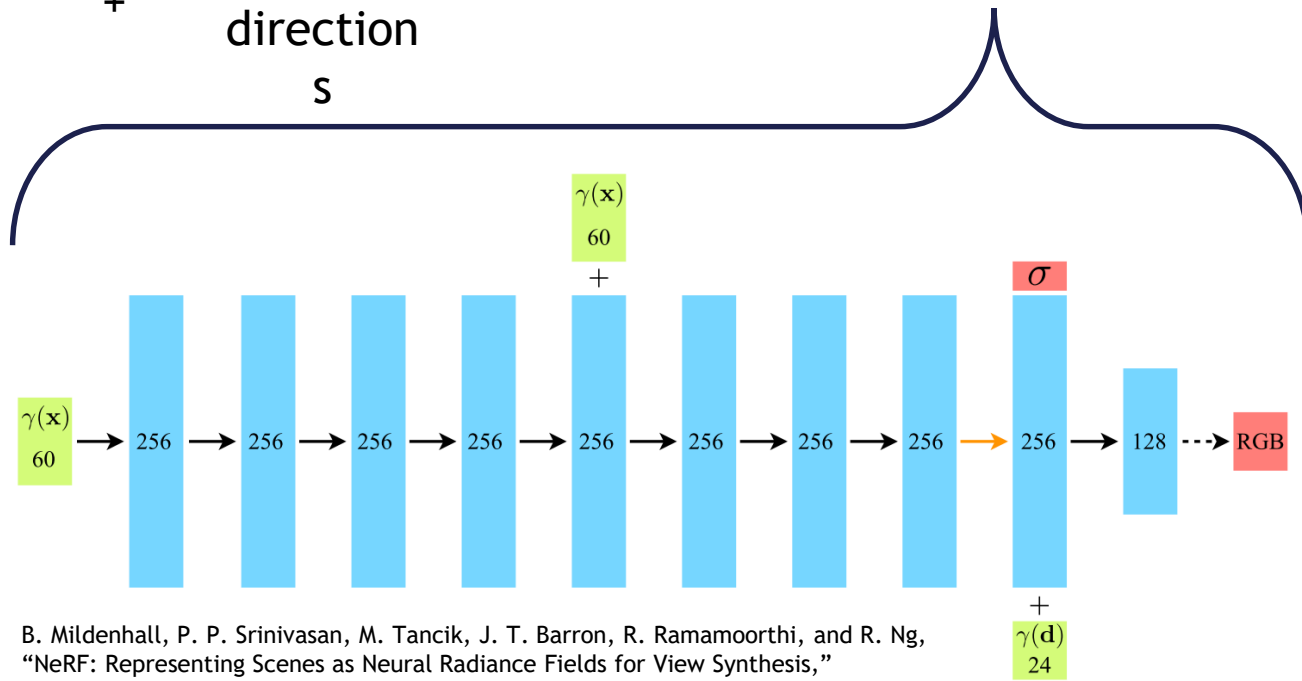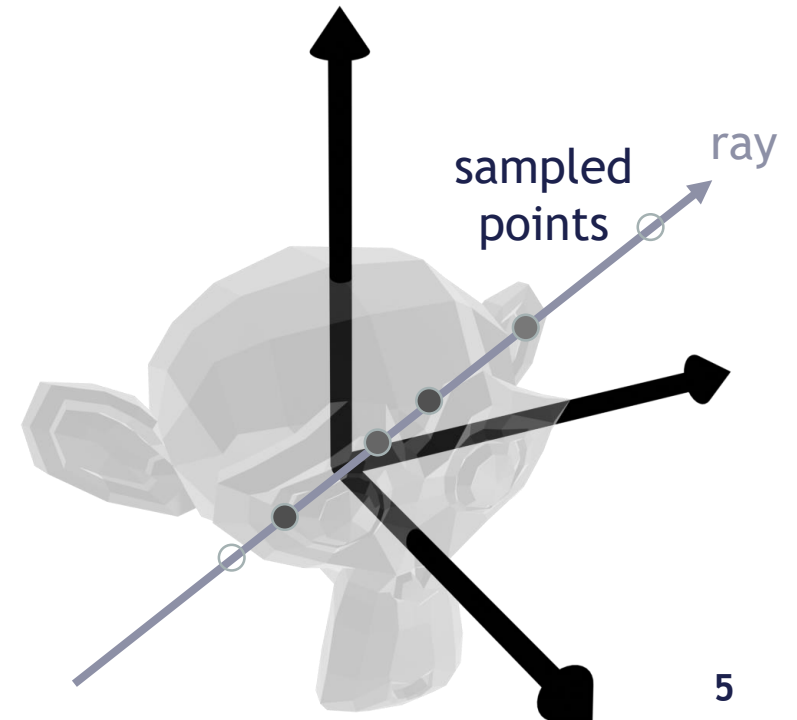
(θ, ϕ)

viewing
directions

Related Work
Neural Radiance Field (NeRF)

points + viewing directions

Neural Radiance Field (NeRF)

densities + view-dependent color

$\gamma(\mathbf{x})$ 60

σ

$\gamma(\mathbf{x})$ 60 → 256 → 256 → 256 → 256 → 256 → 256 → 256 → 256 → 256 → 128 ⇢ RGB
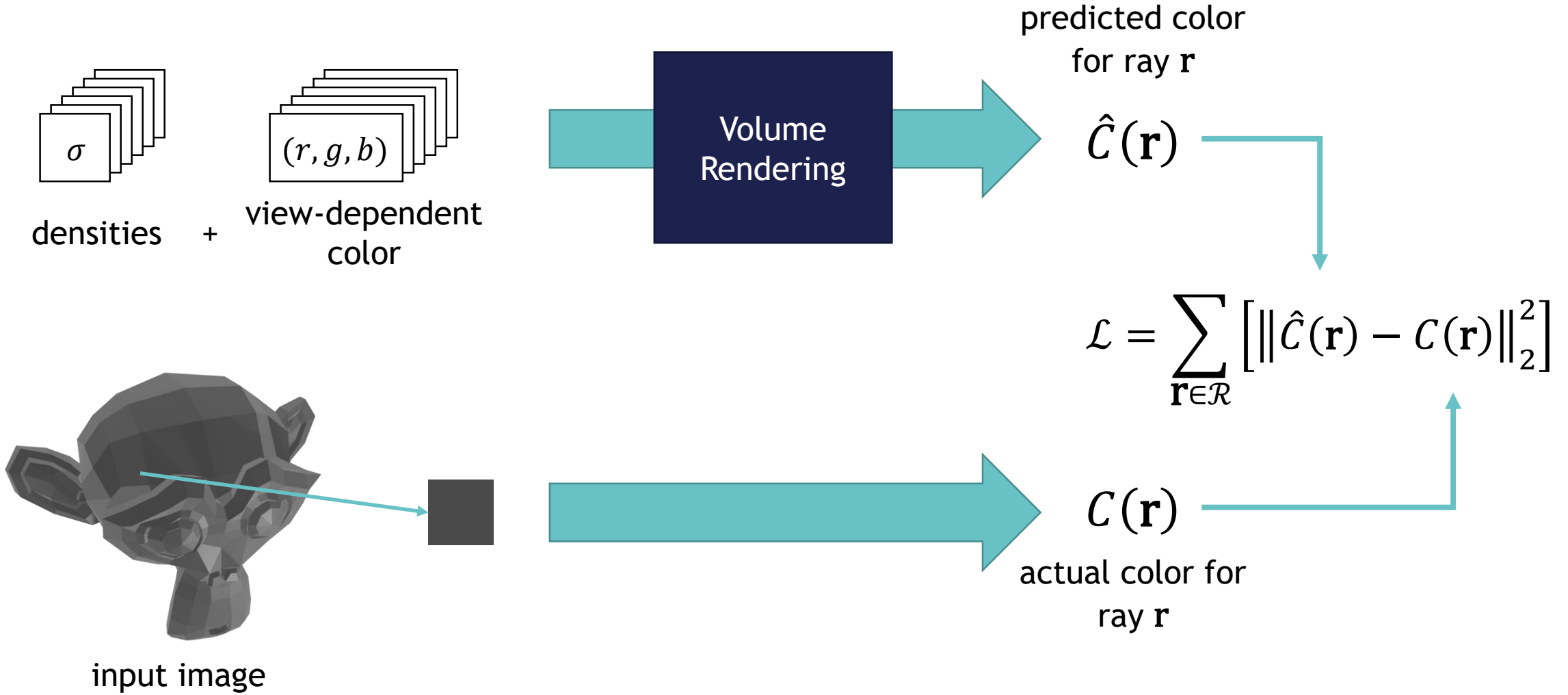
$\gamma(\mathbf{d})$ 24

B. Mildenhall, P. P. Srinivasan, M. Tancik, J. T. Barron, R. Ramamoorthi, and R. Ng, "NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis," arXiv:2003.08934 [cs], Aug. 2020. Available: https://arxiv.org/abs/2003.08934

sampled points

ray

Related Work
Neural Radiance Field (NeRF)

densities + view-dependent color

Volume Rendering

predicted color for ray $\mathbf{r}$

$$\hat{C}(\mathbf{r})$$

$$\mathcal{L} = \sum_{\mathbf{r} \in \mathcal{R}} \left[\left\| \hat{C}(\mathbf{r}) - C(\mathbf{r}) \right\|_2^2 \right]$$

$$C(\mathbf{r})$$

actual color for ray $\mathbf{r}$

input image

Problems

- Large, unbounded scenes

- Highly-dynamic traffic

H. Caesar, V. Bankiti, A. H. Lang, S. Vora, V. E. Liong, Q. Xu, A. Krishnan, Y. Pan, G. Baldan and O. Beijbom, "nuScenes: A multimodal dataset for autonomous driving",In CVPR 2020.

Architecture
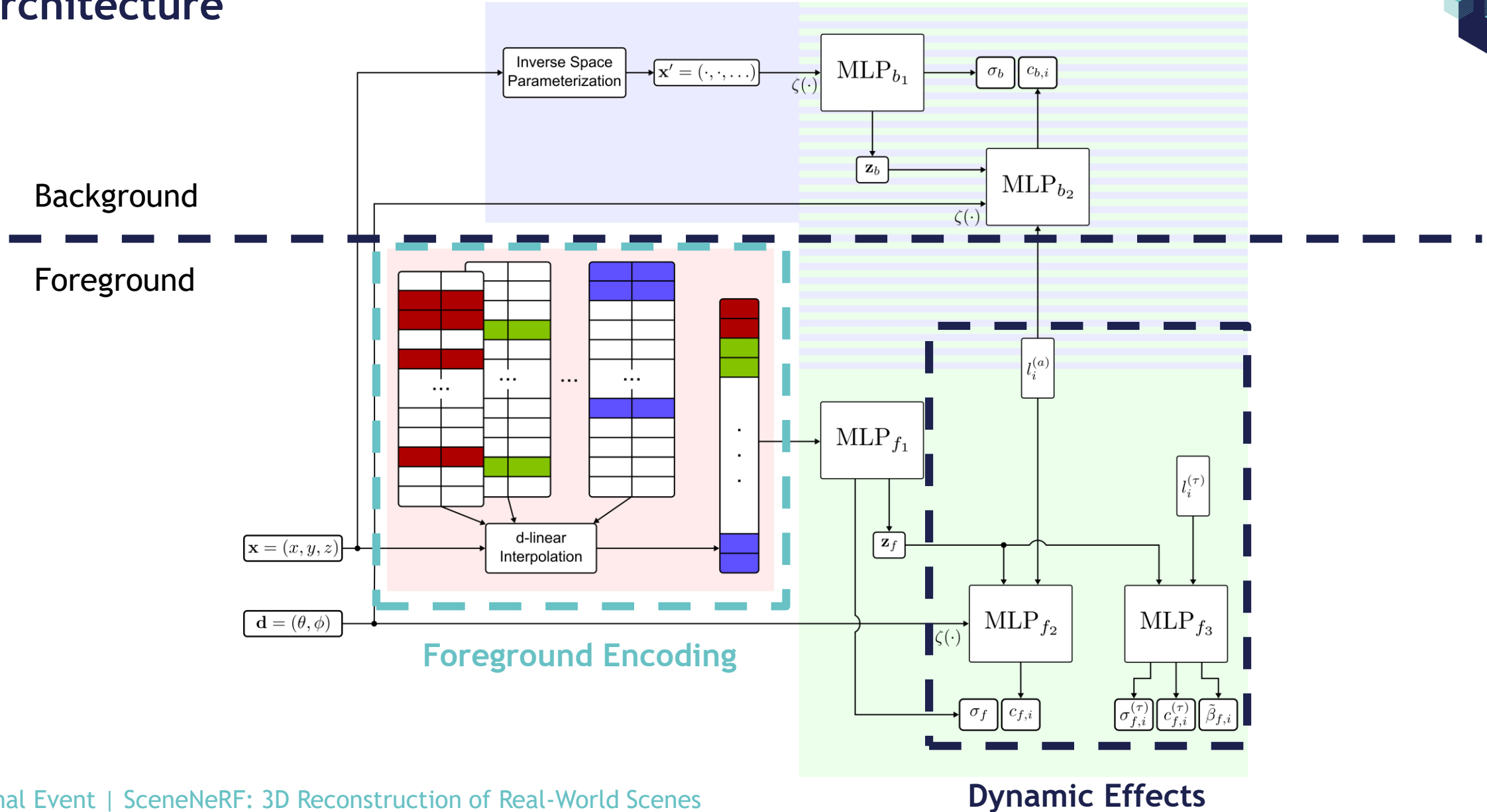
Benchmarks
Setting 1: No traffic

Benchmarks
Setting 2: Traffic

Results @ Setting 1
Default NeRF

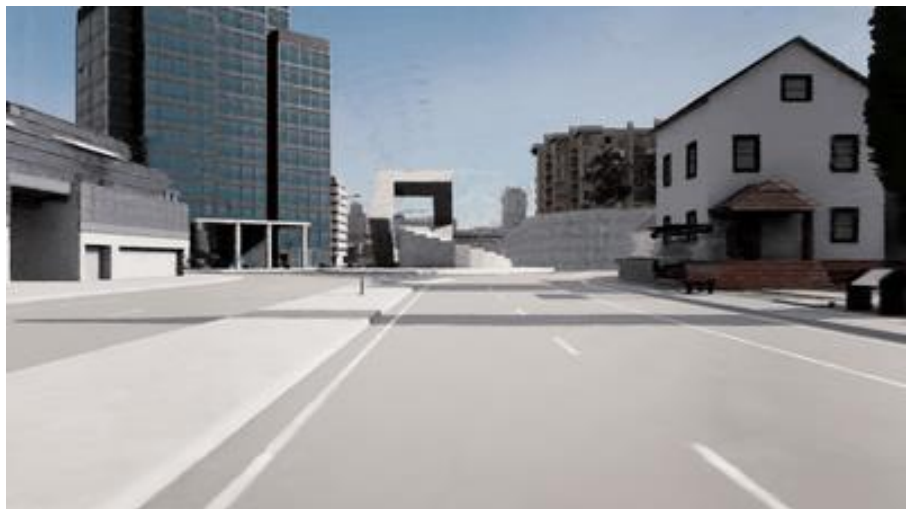Training time: ~8h

Results @ Setting 1
NeRF w/ Hash Encoding

Training time: ~9min

Final Event | SceneNeRF: 3D Reconstruction of Real-World Scenes
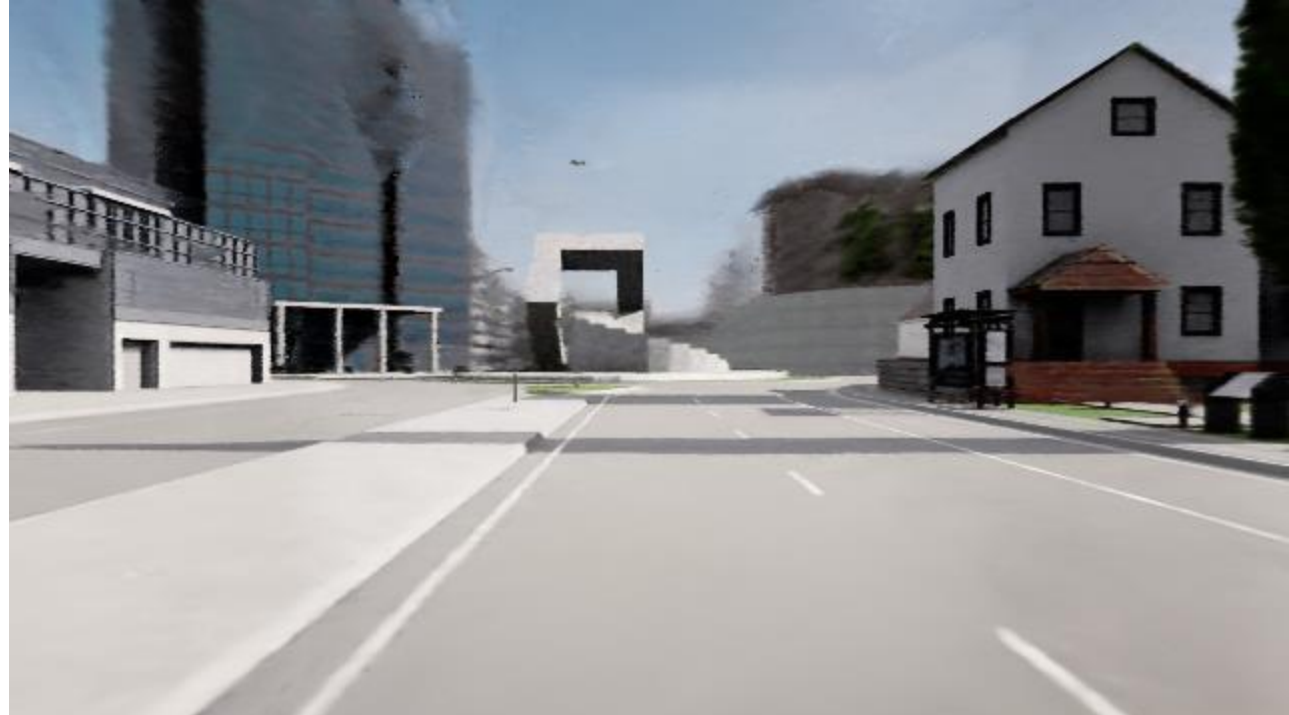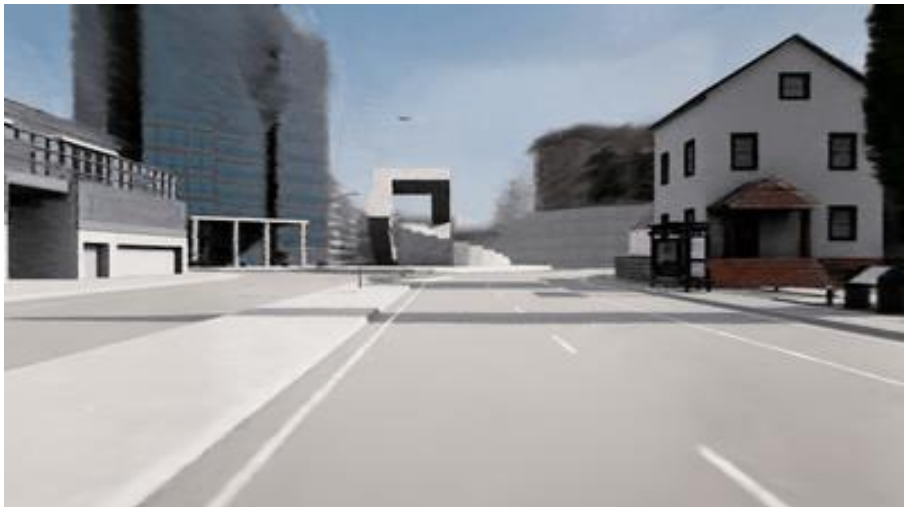
Results @ Setting 1
NeRF + Hash Encoding + FG/BG Separation

Training time: ~20min

Results @ Setting 2
SceneNeRF

Training time: ~22min
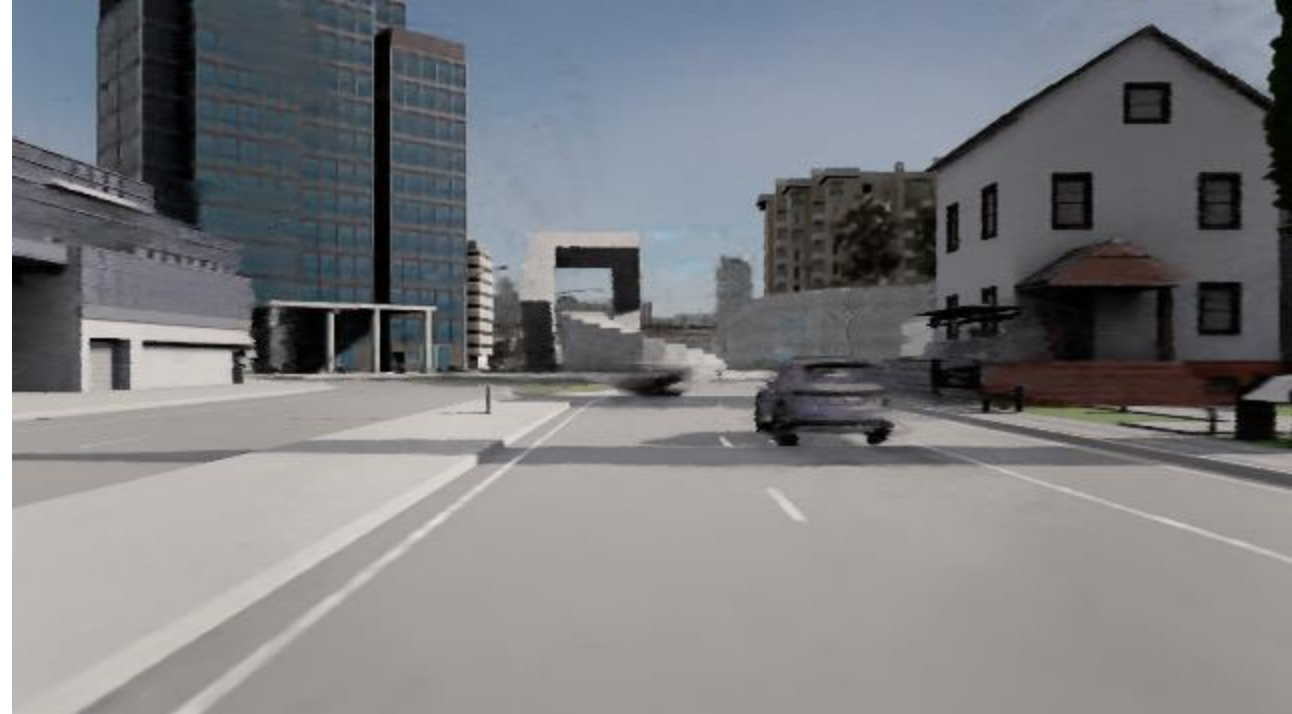
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KI Delta Learning is a project of the KI Familie. It was initiated and developed by the VDA Leitinitiative autonomous and connected driving and is funded by the Federal Ministry for Economic Affairs and Climate Action.

www.ki-deltalearning.de @KI_Familie KI Familie

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KI FAMILIE

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