

Non-uniform Sampling Strategies for NeRF on 360° images

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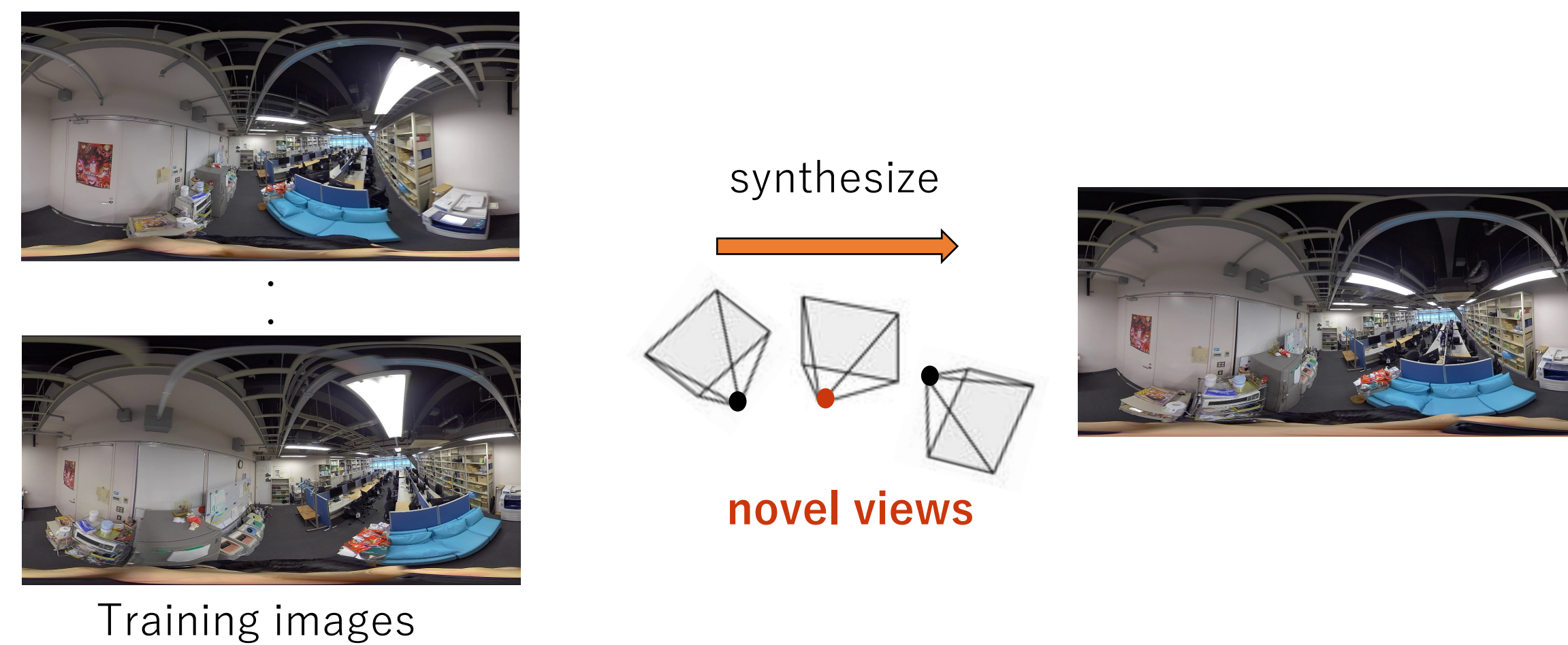
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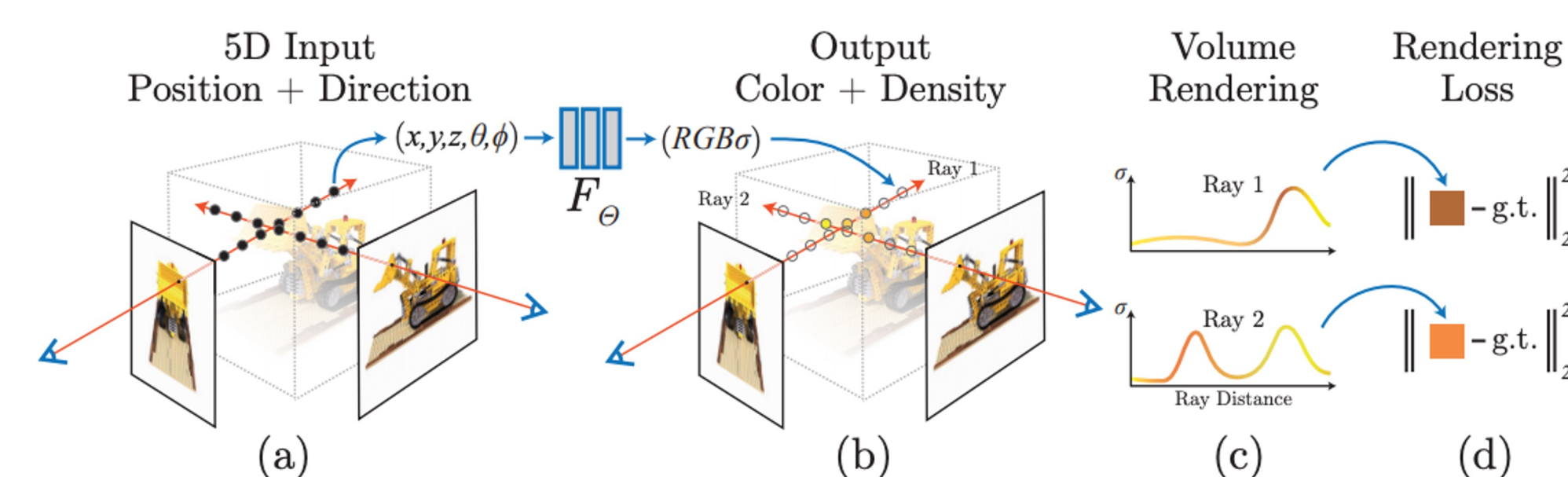
² National Institute of Informatics

Background

Novel view synthesis for 360° images in ERP format with NeRF



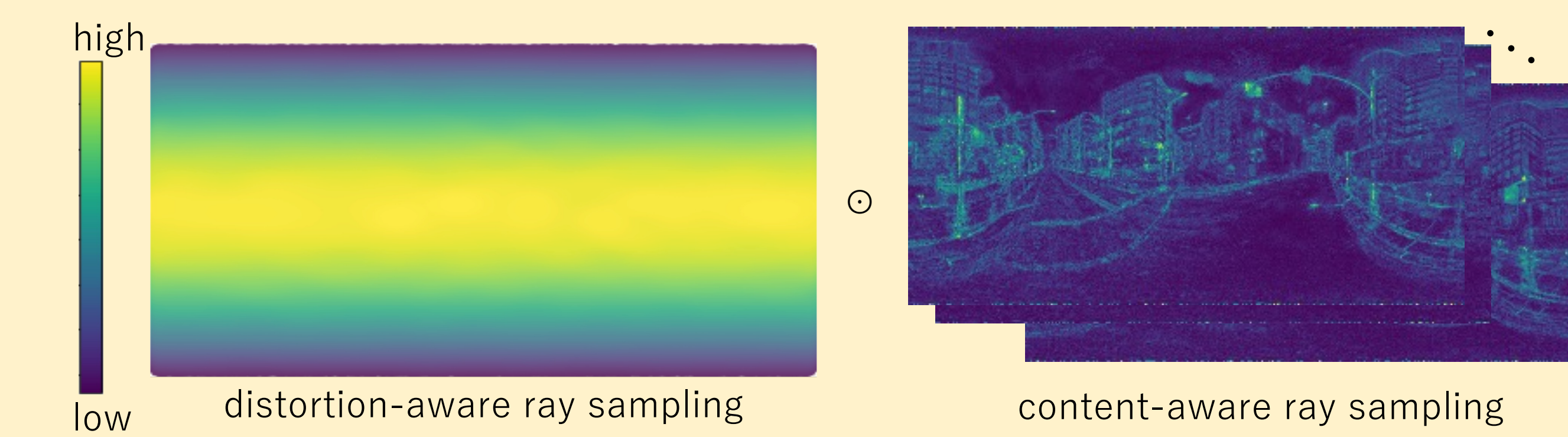
Neural Radiance Fields (NeRF) [1]



$$C(\mathbf{r}) = \int_{t_n}^{t_f} T(t) \sigma(\mathbf{r}(t)) c(\mathbf{r}(t), \mathbf{d}) dt, \text{ where } T(t) = \exp\left(-\int_{t_n}^t \sigma(\mathbf{r}(s)) ds\right)$$

Method

two non-uniform sampling strategies



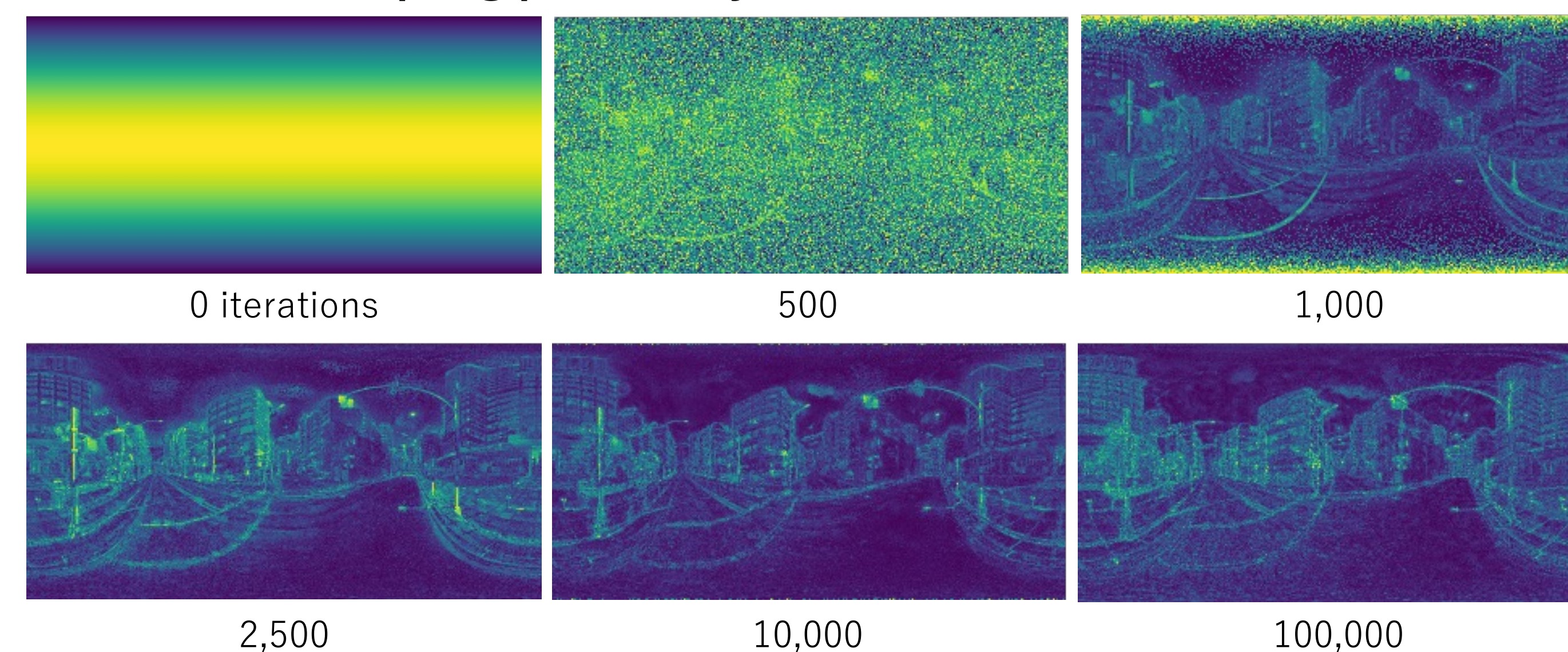
distortion-aware ray sampling

take into consideration the spatial distortion,
the **higher** sampling probability are assigned to **lower-latitude** regions
the **lower** sampling probability are assigned to the **higher-latitude** regions

content-aware ray sampling

take into the consideration the reconstruction loss of each pixel,
the **higher** sampling probability are assigned to **higher-texture** regions
the **lower** sampling probability are assigned to **lower-frequency** regions

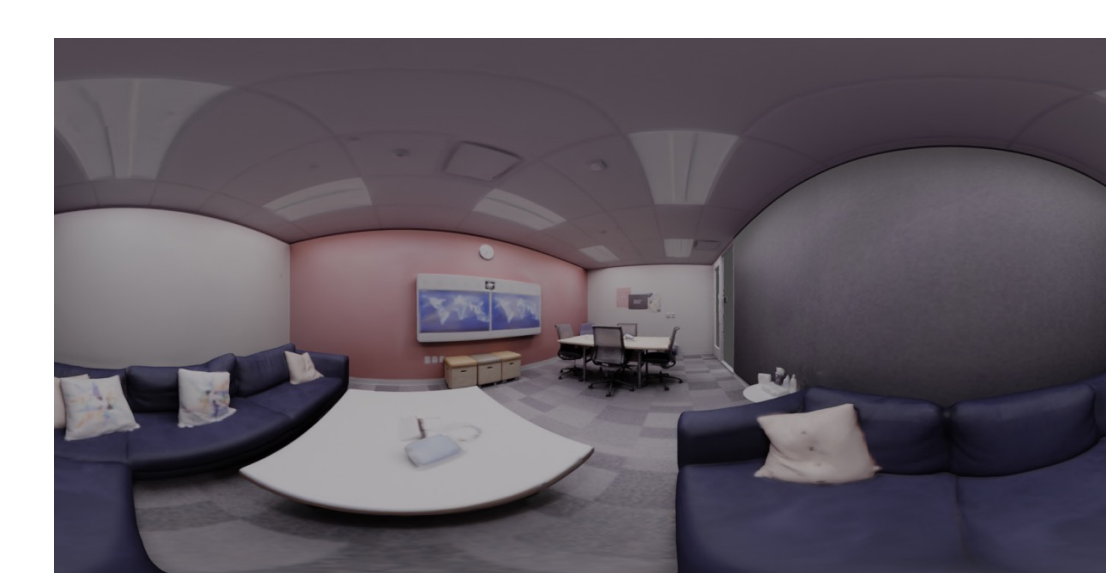
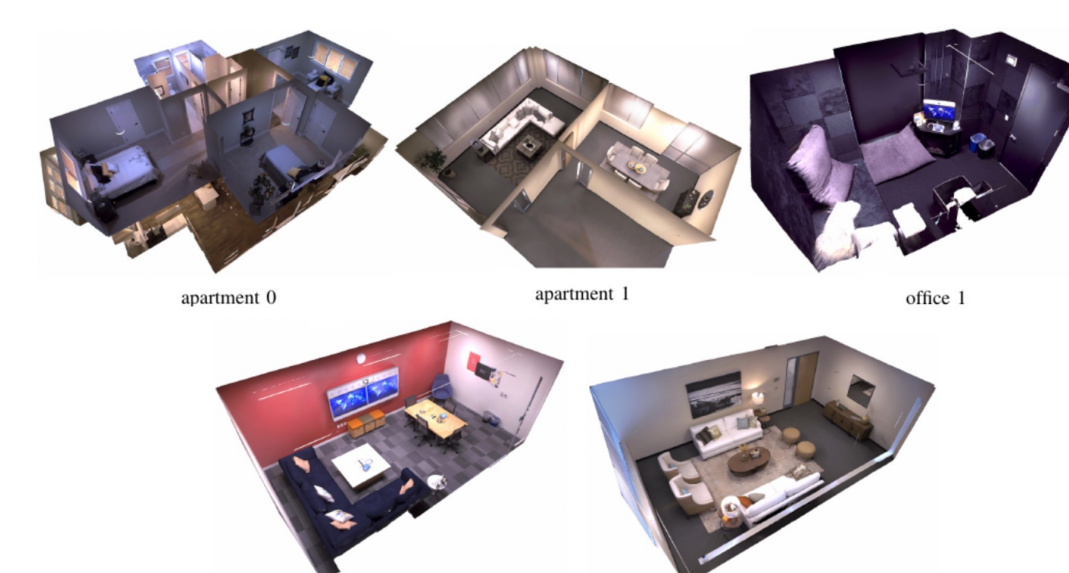
transition in sampling probability



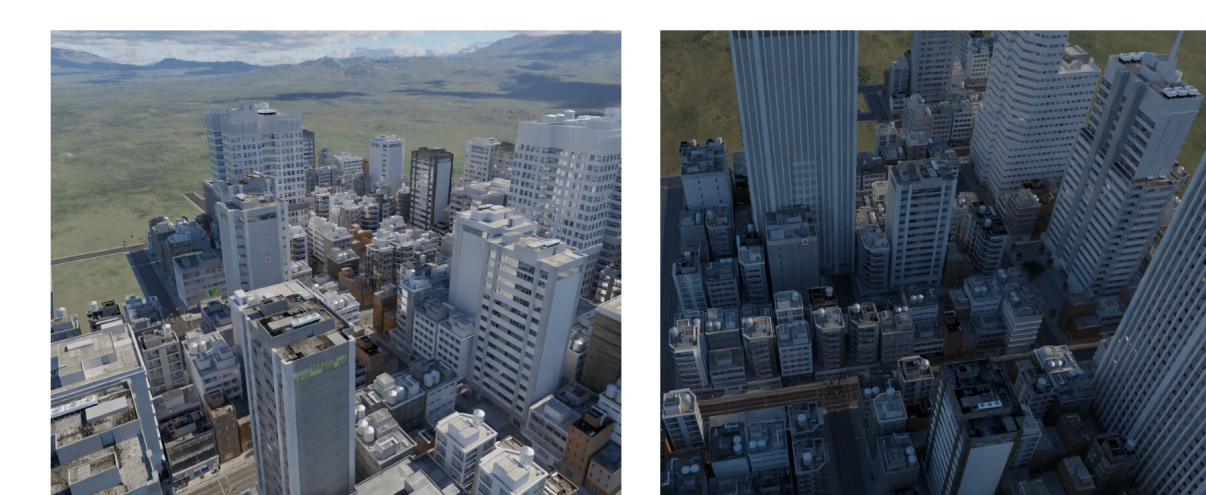
Synth360

Create synthetic datasets Synth360 without camera parameter errors

• Replica Dataset [2]

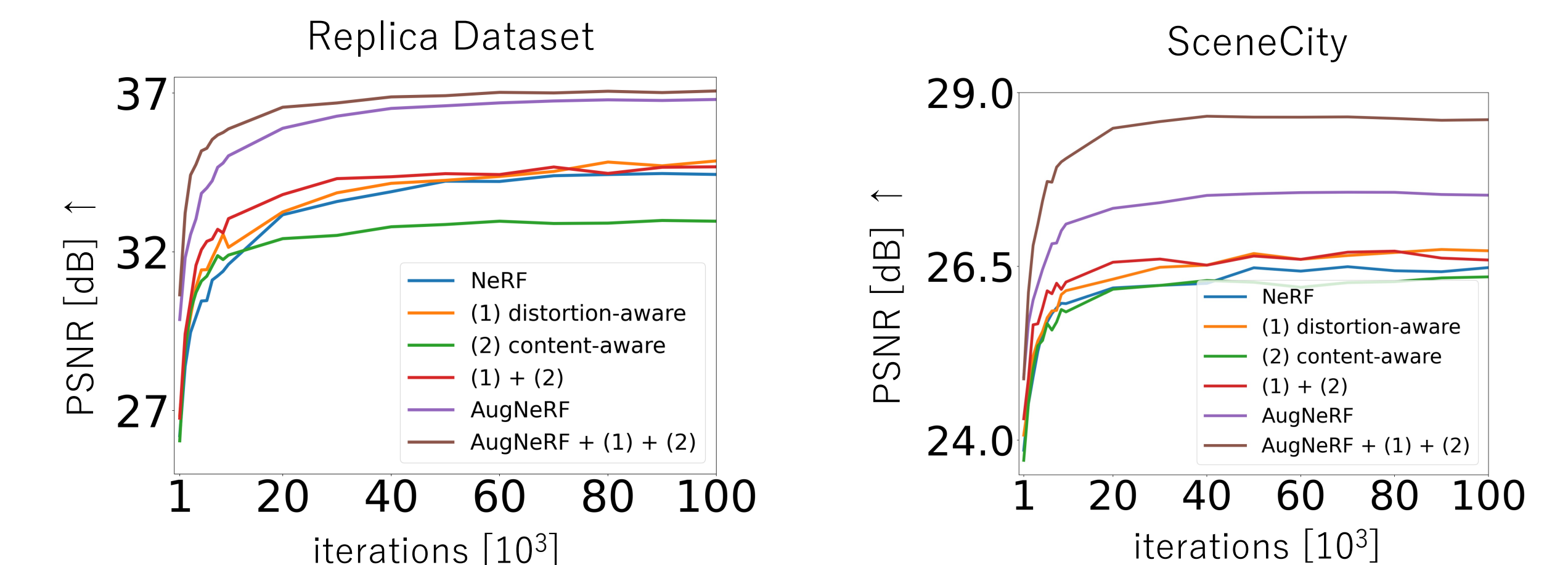


• SceneCity [3]



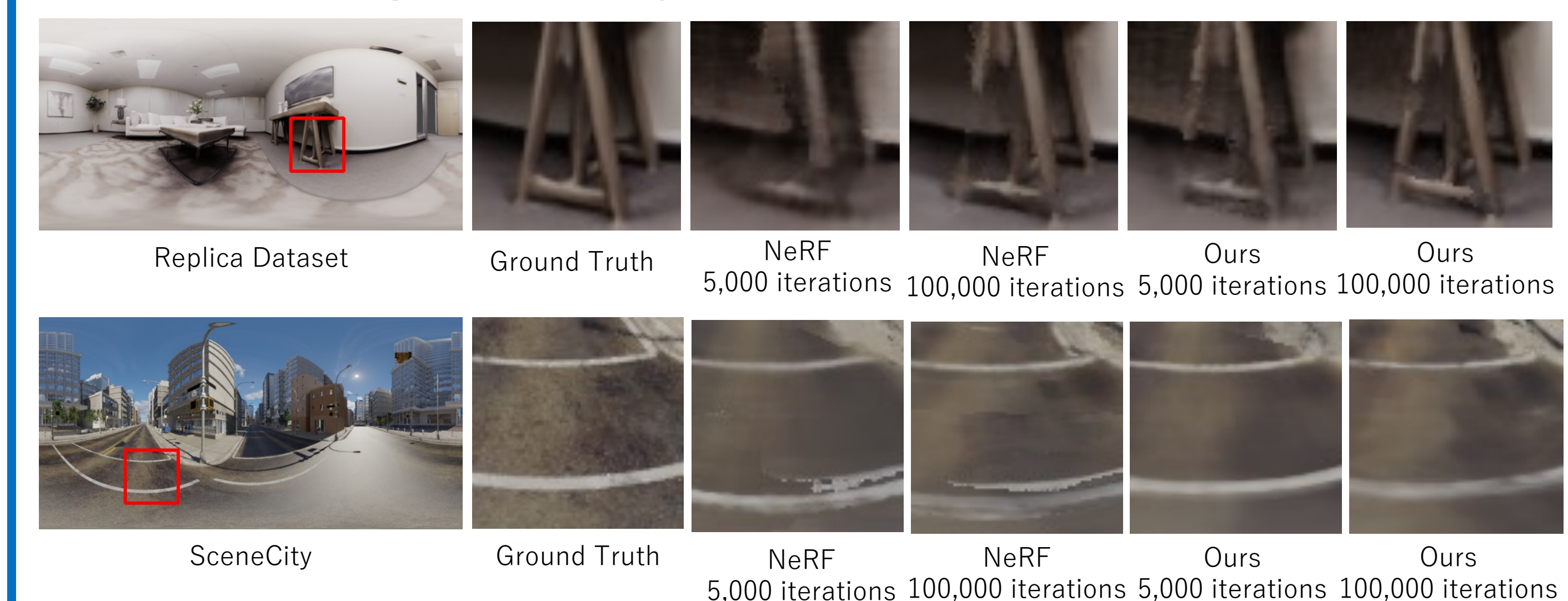
Experiments

Effect of each sampling strategy



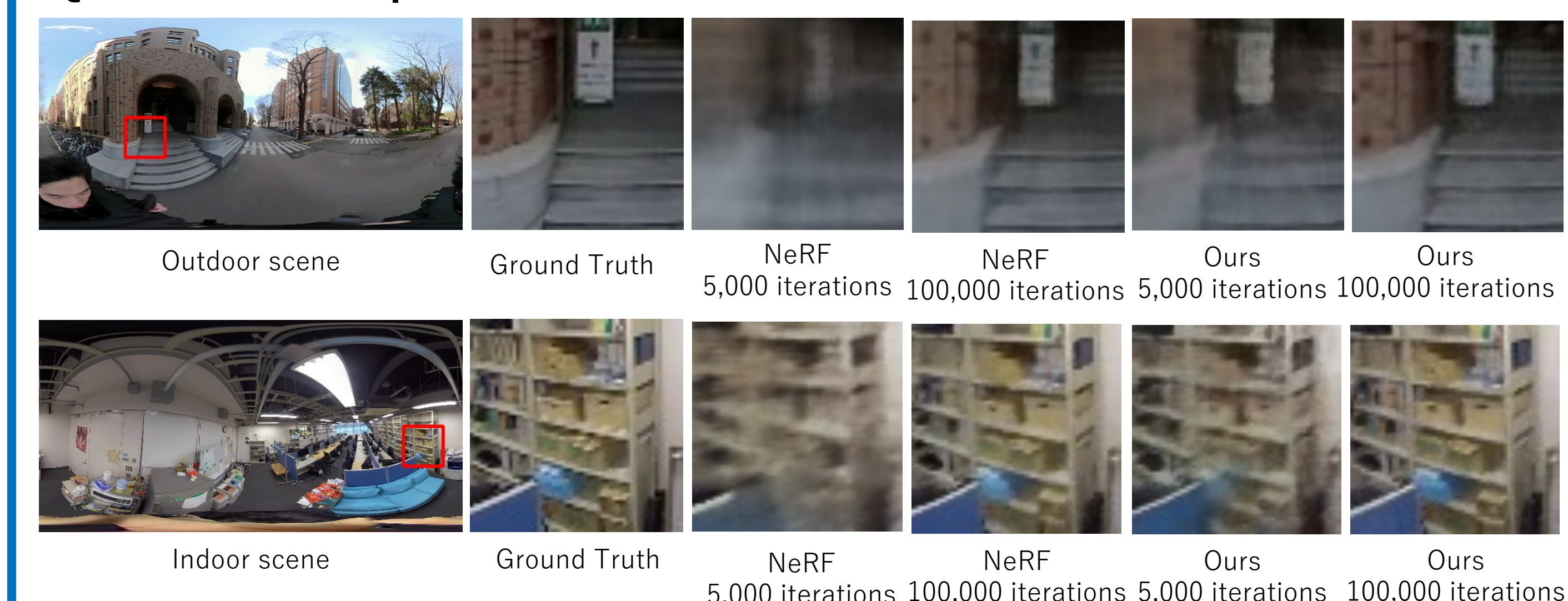
- Our method is superior to the original NeRF in both **efficiency** and **accuracy**.
- The advanced variant of NeRF (AugNeRF [4]) also improve accuracy.

Qualitative comparison on Synth360



- Our proposed method has improved the quality in the high-frequency texture regions.

Qualitative comparison on real-world scenes

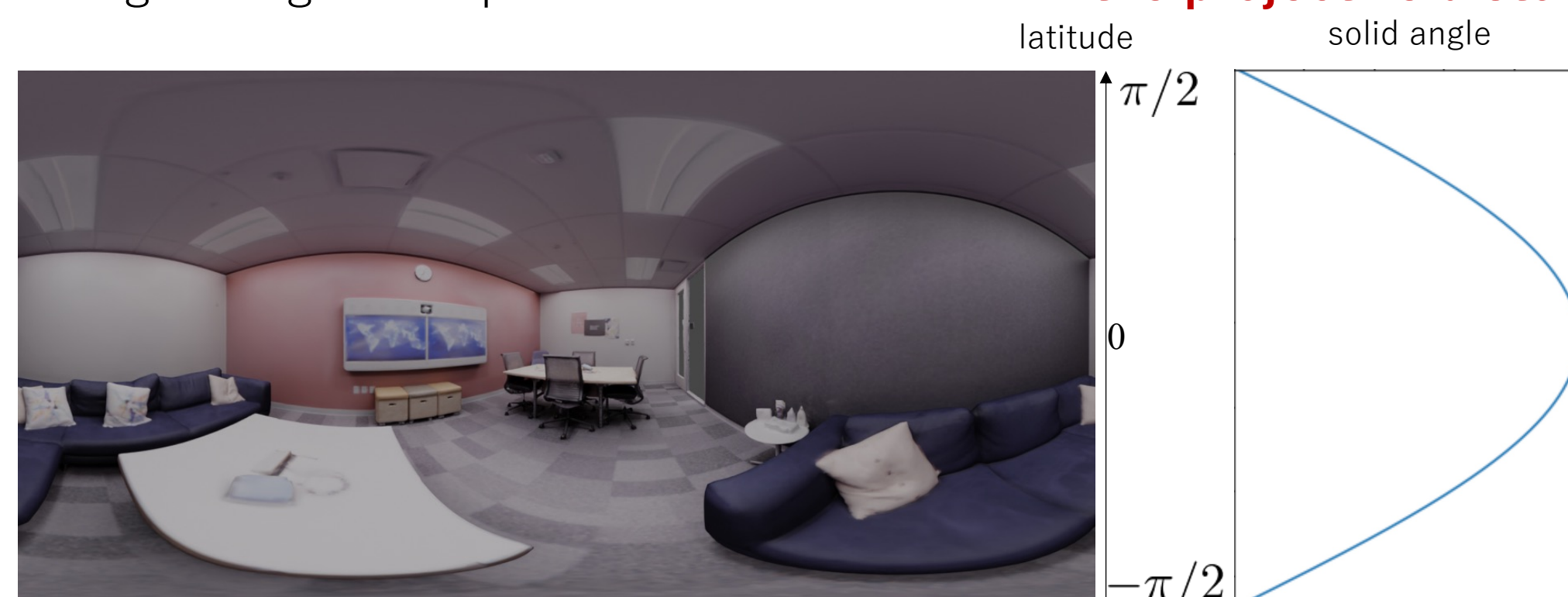


- We show that our method enhances the quality of real-world scenes in 360° images.

Problems with 360° image NeRF

Spatial distortion

The uniform sampling strategy theoretically becomes problematic as the 3-D coverage of each ray passing through each pixel is not uniform due to **the projective distortion**.



Wide viewing angle

It is wasteful to keep spending the same amount of learning resources to **the low-frequency texture regions** as are spent on the high-frequency textured regions.



Indoor Scene

Outdoor Scene

References

- [1] B.Mildenhall, et al. "NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis." ECCV, 2020.
- [2] J.Straub, et al. "The Replica Dataset: A Digital Replica of Indoor Spaces." arXiv:1906.05797, 2019.
- [3] SceneCity. <https://www.cgchan.com/store/scenecity>
- [4] T.Chen, et al. "Aug-NeRF: Training Stronger Neural Radiance Fields With Triple-Level Physically-Grounded Augmentations.", CVPR, 2022.