NeRF for Outdoor Scene Relighting

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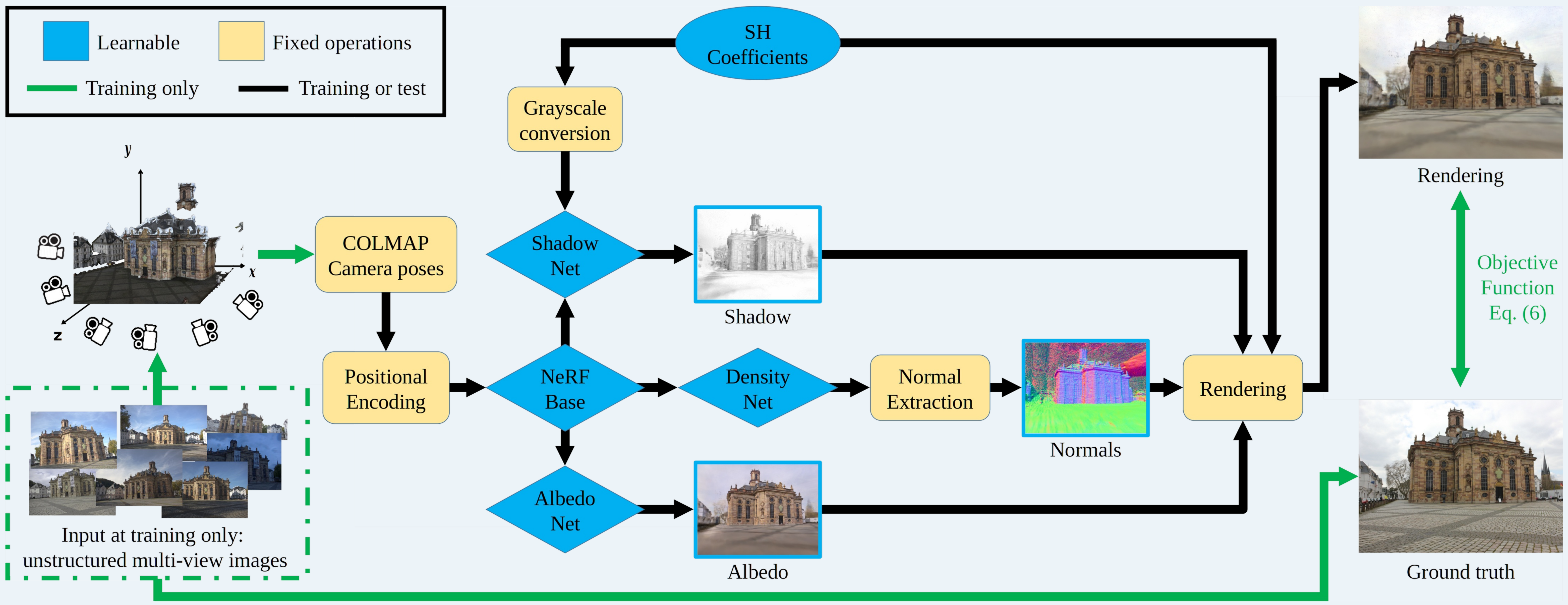
4dqv.mpi-inf.mpg.de/NeRF-OSR

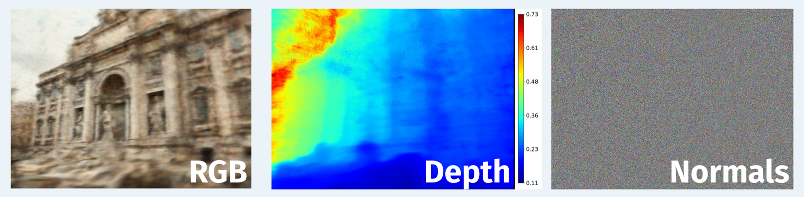
Method



$$L = L_{reconstruction} + L_{shadow}, \; L_{shadow} = \lambda(1-s)^2,$$

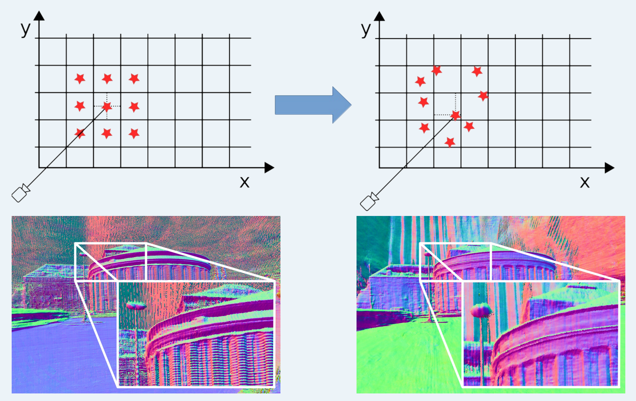
Loss function is the mean-squared error between the reconstructed image and the ground-truth and, in addition, the **shadow regularizer** term.

The latter prevents the shadow network from learning all of the illumination effects which should be learned with the SH illumintaion components



To prevent the collapse of geometry and normals as in the example above, we apply **frequency annealing** introduced in Park et al.:

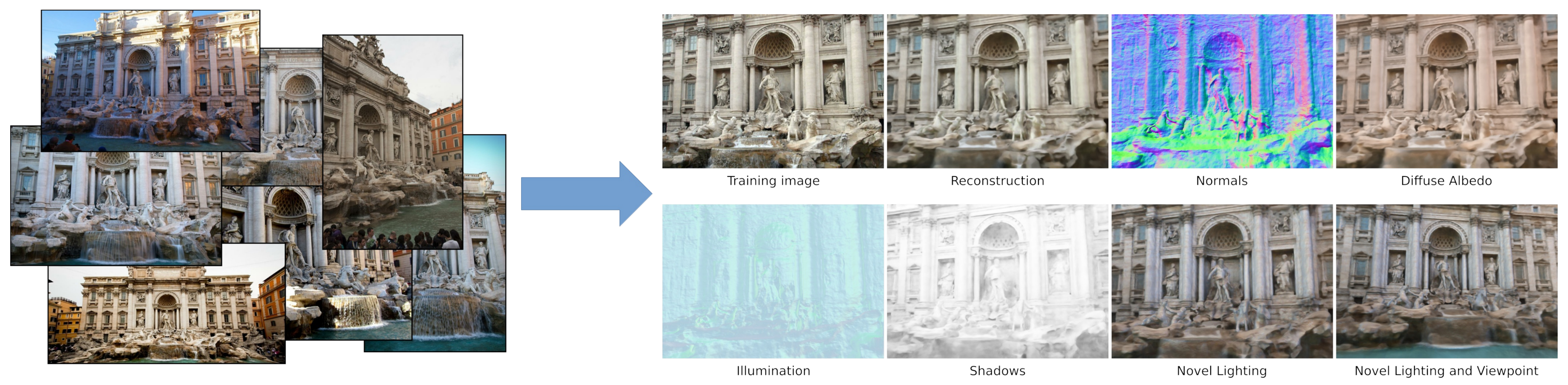
$$w_j(\alpha) = \frac{(1-\cos(\pi\,\mathrm{clamp}(\alpha - j, 0, 1))}{2}$$



To prevent overfitting of normals we apply **ray direction jitter**

To improve generalisation of the shadow network, we apply a **small noise vector** to its environment map coefficients input

Problem

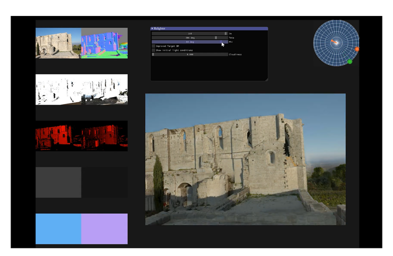


Novel viewpoint and relighting **at the same time** from 50-300 **in-the-wild** photos

Related work

NeRF
(Only novel viewpoint)

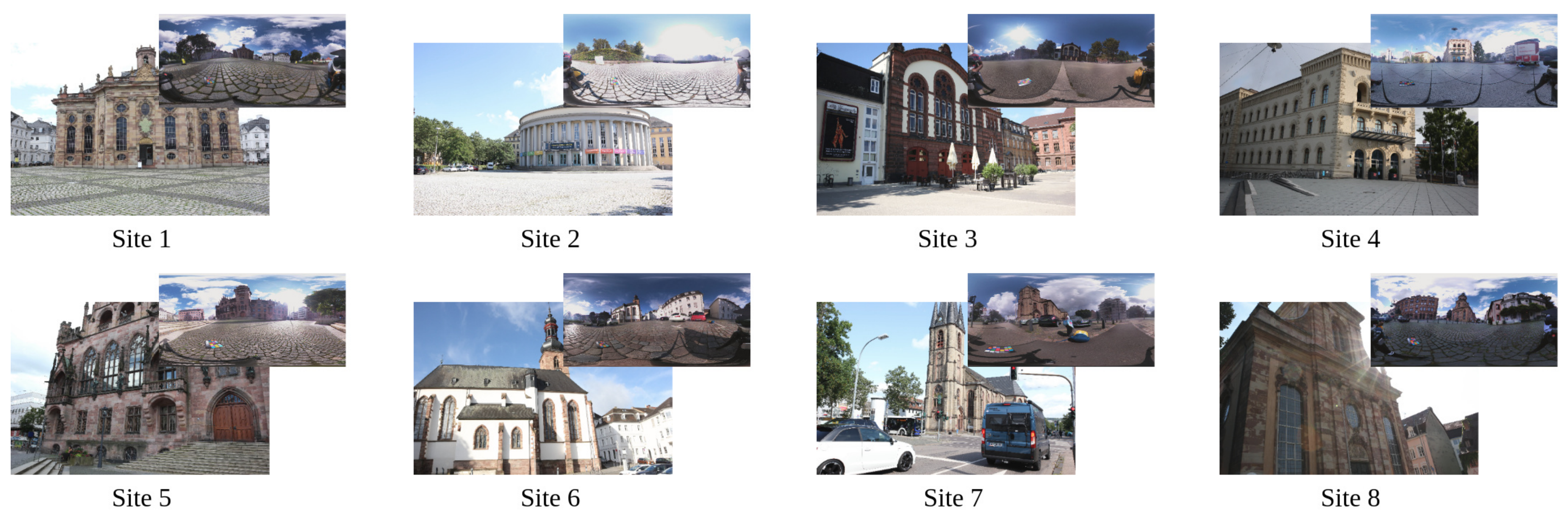
Yu et al.
(Only novel lighting)

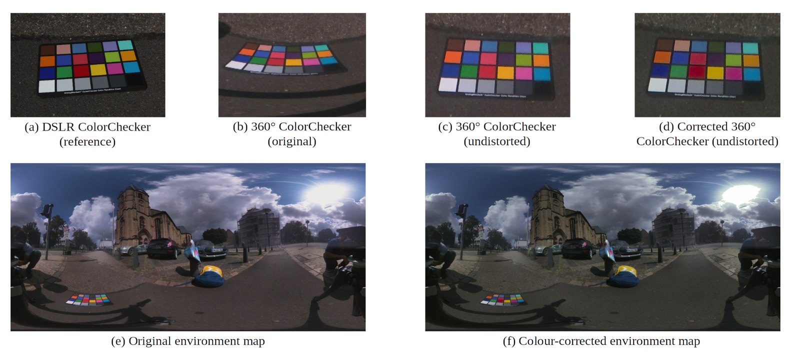


Philip et al.
(Only novel lighting)

NeRF-W
(No semantic control)

New Dataset with Environment Maps





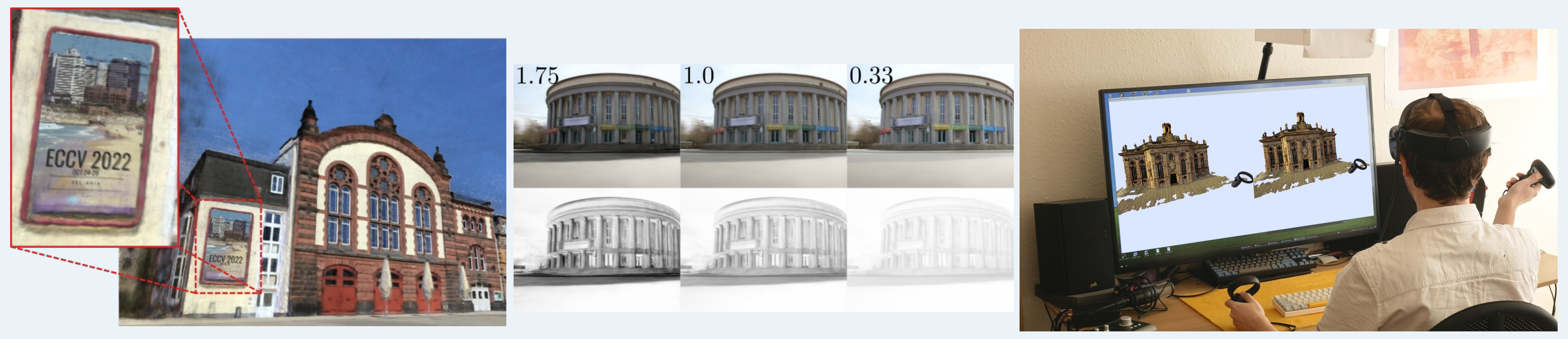
We colour-correct environment maps using a **GretagMacbeth ColorChecker** captured on both the 360° environment photos and DSLR photos

	Sessions	Views
Site 1	18	373
Site 2	17	423
Site 3	16	372
Site 4	11	401
Site 5	13	493
Site 6	12	379
Site 7	11	468
Site 8	12	331
Total	110	3240

Results

Training image · Diffuse Albedo · Surface normals · Shadows · Novel lighting and viewpoint

Additional Applications



Albedo Editing · **Shadow Editing** · **Interactive VR Relighting**

Various Results

Simultaneous relighting and novel view synthesis with our NeRF-OSR, even with **synthetic** lighting conditions, thanks to its **image intrinsic decomposition**

Compared to NeRF-W which can only interpolate between learned illuminations, our NeRF-OSR can synthesise **completely novel lighting conditions** with **full semantic control**

Comparisons to Yu et al. and Philip et al.

Method	PSNR ↑	MSE ↓	MAE ↓	SSIM ↑
	Site 1			
Yu *et al.* [46]	18.71	0.014	0.088	0.4
Philip *et al.* [27] (d/s)	17.37	0.019	0.105	0.429
Ours (d/s)	**19.86**	**0.011**	**0.08**	**0.626**
Yu *et al.* [46] (u/s)	17.87	0.017	0.097	0.378
Philip *et al.* [27]	16.63	0.023	0.113	0.367
Ours	**18.72**	**0.014**	**0.09**	**0.468**
No shadows	17.82	0.017	0.101	0.418
No annealing	17.16	0.02	0.108	0.324
No ray jitter	18.43	0.015	0.093	0.433
No shadow jitter	18.28	0.016	0.095	0.413
No shadow regulariser	17.62	0.018	0.105	0.373

References: Yu et al. "Self-supervised Outdoor Scene Relighting", ECCV 2020
Philip et al., "Multi-view Relighting Using a Geometry-Aware Network", SIGGRAPH 2019
Mildenhall et al., "NeRF: Representing Scenes as Neural Radiance Fields for View Synthesis", ECCV 2020
Martin-Brualla et al., "NeRF-W: Neural Radiance Fields for Unconstrained Photo Collections", CVPR 2021

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