

# Time-conditioned Illumination for Inverse Rendering of Outdoor Scenes

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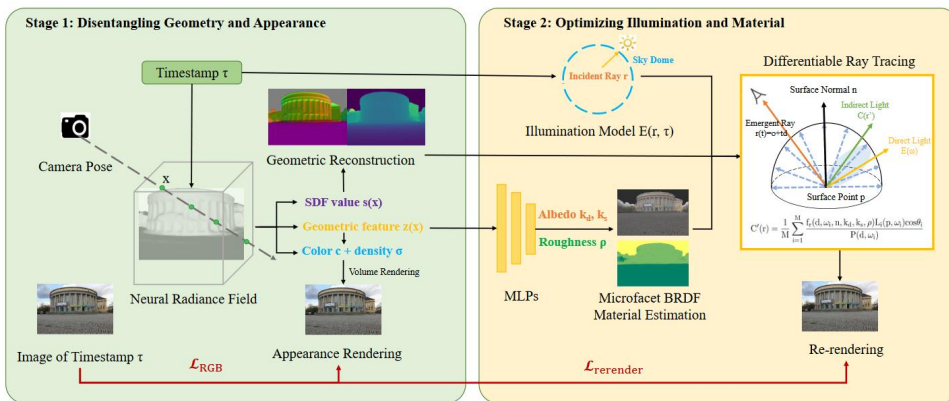
## Motivation

While previous inverse rendering works mainly focus on object-level or indoor scenes, addressing the inverse rendering problem for **outdoor scenes** poses more challenges, which arise from the **complex geometry** and **time-variant nature of outdoor illumination** due to changing sun position and atmosphere condition.

## Contribution

1. Incorporate monocular geometry cues for high-quality reconstruction.
2. Present a time-dependent lighting field that utilize images under various illuminations.
3. Parameterize the scene's materials with the microfacet BRDF function and introduce a physically-based differentiable re-renderer.
4. Facilitates various scene editing applications with high-fidelity results.

## Overall Architecture



### Two-stage Training

1. Disentangle the underlying geometry from appearance based on NeRF
2. Optimize the illumination and material parameters, a re-rendered image can be generated with differentiable rendering pipeline.

## Experiment Results

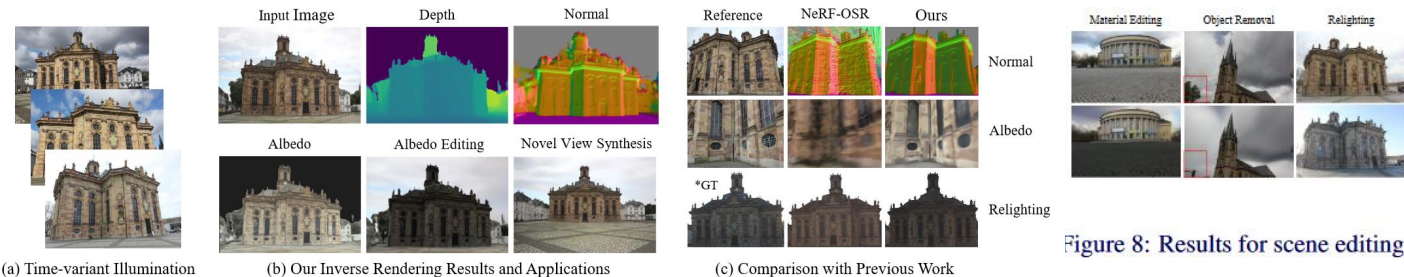


Figure 8: Results for scene editing.

Method	PSNR↑	SSIM↑
Nerfacto [42]	16.722	0.647
InstantNGP [32]	19.735	0.770
Ours (w/o $\mathcal{L}_{normal}$ )	19.218	0.732
Ours	<b>20.031</b>	<b>0.775</b>

Table 1: Quantitative results for novel view synthesis on TnT dataset.

Method	PSNR↑	SSIM↑
End-to-end	14.533	0.412
Two-stage	<b>20.438</b>	<b>0.623</b>
Time-invariant	23.201	0.724
Time-variant	<b>24.435</b>	<b>0.734</b>

Table 2: Ablation study on the training process and the time-variant illumination.

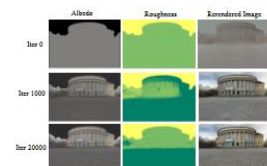


Figure 5: The material optimization process on NeRF-OSR dataset.