NEMTO: Neural Environment Matting for Novel View and Relighting Synthesis of Transparent Objects

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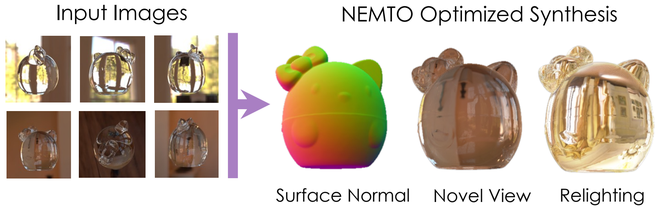
Problem

The entangled geometry and illumination-dependent appearance of transparent objects make it hard to create their 3D representations through 2D images.



NEMTO synthesizes high-quality novel view and relighting by disentangling the geometry and illumination-dependent appearance of a transparent object.

Contributions

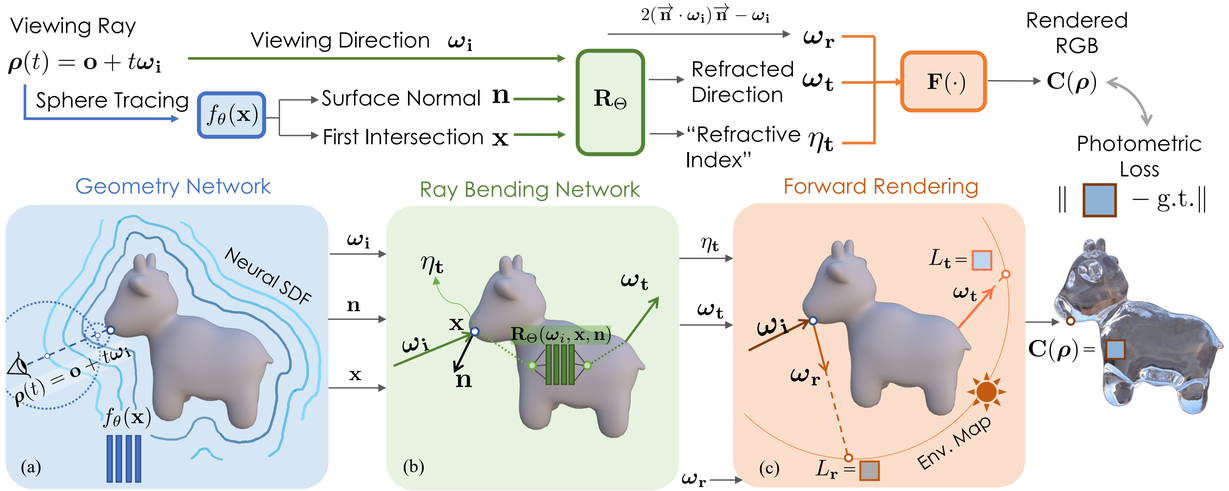
- NEMTO is the first end-to-end method for novel view synthesis and scene relighting for transparent objects.
- A physically-guided Ray Bending Network (RBN) for predicting ray paths through the transparent object with better error tolerance for the estimated geometry than analytically calculated refraction.
- Can model real-world transparent objects by hand-captured image.

Comparison of Relevant Methods

Methods	A	B	C	D	E	F	Task
NeRF	✗	✓	✗	✓	✓	✗	Img-Based Synthesis
Eikonal [2022]	✓	✓	✗	✓	✓	✗	Img-Based Synthesis
IDR [2020]	✗	✓	✗	✓	✓	✗	Img-Based Synthesis
PhySG [2021]	✗	✓	✓	✓	✗	✓	Img-Based Synthesis
NEMTO	✓	✓	✓	✓	✓	✗	Img-Based Synthesis
Hybrid [2022]	✓	✗	✗	✗	✗	✗	Geo. Est.
TLG [2020]	✓	✗	✗	✓	✗	✗	Geo. Est.

A. Model refraction.
B. Direct novel view.
C. Direct relighting.
D. Simple Setup.
E. Unknown IOR.
F. Illumination estimate

Overview of NEMTO Framework

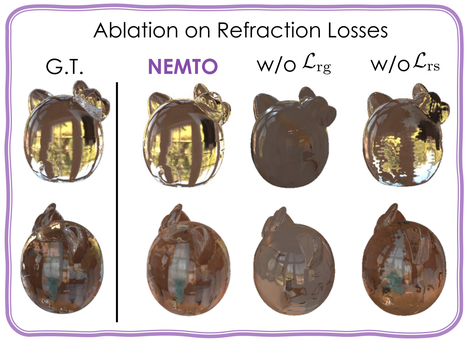


Loss Functions

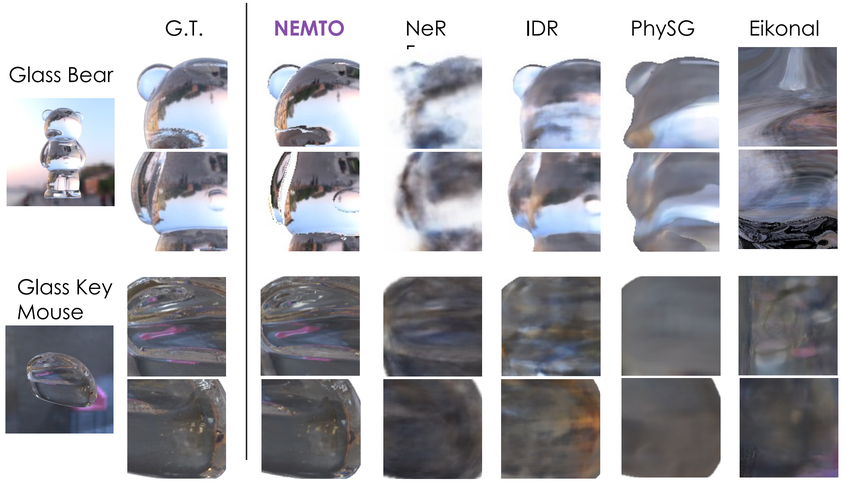
For ray refraction estimation, we use two losses:

$\mathcal{L}_{\text{rg}}$ guides the refraction direction exiting the object toward the analytical solution.

$\mathcal{L}_{\text{rs}}$ encourages locally smooth refraction directions.



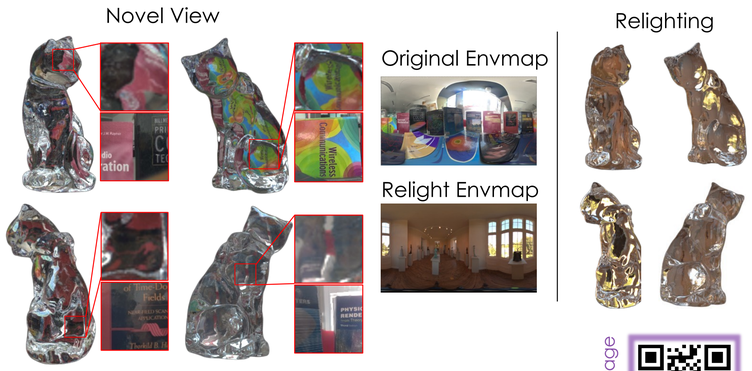
Novel View Comparison to Baseline Methods



Relighting Results

Synthesis on Real-World Captured Dataset

Despite the inaccuracy in real-world camera poses and captured environment maps, NEMTO synthesizes visually-plausible novel views and relighting results,



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