ISCAS 中国科学院软件研究所学术年会'2022 暨计算机科学国家重点实验室开放周
学术论文

可重光照的参与介质神经渲染

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Title：Neural Relightable Participating Media Rendering

Venue：Thirty-fifth Conference on Neural Information Processing Systems (*NeurIPS* 2021), 34, 15203-15215

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Background & Overview

- Participating media are media whose particles participate in the light transport when light enters the media.
- Previous acquisition methods require sophisticated apparatus and carefully designed lighting conditions, which makes the capture cumbersome.

Typical participating media

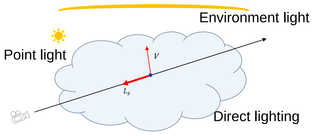
- We propose a method for participating media acquisition.
- This method can learn disentangled density and scattering albedo, and allows decomposition of direct and indirect lighting in unsupervised manner.

Method

- Cope with holistic illumination by simulating single scattering and multiple scattering

➢ Single Scattering

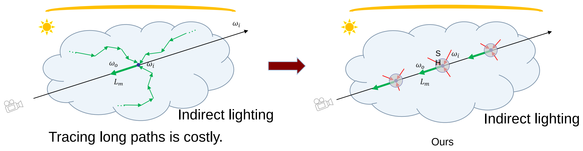
- Compute with exact ray tracing
- Predict visibility for shadow rays



$$L_s = \int_{\Omega_{4\pi}} a(x_t) \cdot \rho(\omega_o, \omega_i) \cdot L_e(x_t, \omega_i) \cdot V(x_t, \omega_i) \mathrm{d}\omega_i$$

➢ Multiple Scattering

- Aggregate incident radiance of rays that have been scattered at least once
- Approximate radiance with spherical harmonics expansion

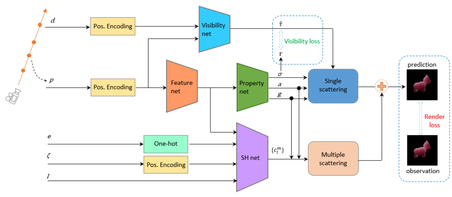


$$L_m = \int_{\Omega_{4\pi}} a(x_t) \cdot \rho(\omega_o, \omega_i) \cdot F\left(\sum_{l=0}^{l_{max}} \sum_{m=-l}^{l} c_l^m Y_l^m(\omega_i)\right) \mathrm{d}\omega_i$$

➢ Difference in Properties

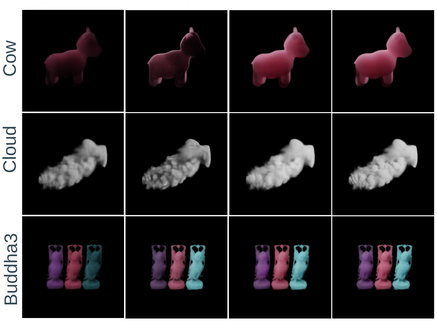
	Solid scenes	Participating media
Radiance	✓ Color c	✓ Single scattering L_s ✓ Multiple scattering L_m
Property	✓ Volume density σ	✓ Volume density σ ✓ Scattering albedo a ✓ Phase function parameter g

➢ Framework



Results

- **Qualitative comparison on test view**



- **Quantitative comparison**

Method	Cow			Cloud			Buddha3		
	PSNR	SSIM	ELPIPS	PSNR	SSIM	ELPIPS	PSNR	SSIM	ELPIPS
Bi et al.	24.70	0.958	0.465	20.92	0.921	0.783	29.47	0.970	0.299
NeRV	25.20	0.960	0.540	25.68	0.949	0.526	28.69	0.969	0.315
Ours	**34.20**	**0.983**	**0.184**	**33.51**	**0.974**	**0.302**	**33.77**	**0.975**	**0.245**

- **Enable scene compositions**

Our composition Ground truth

- **Enable flexible scene editing**

Learnt cloud Edit density Edit albedo