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Weakly-supervised Single-view Image Relighting

Renjiao Yi*, Chenyang Zhu*, Kai Xu (*co-first authors)
National University of Defense Technology

Presenter： Renjiao Yi

国防科技大学
NATIONAL UNIVERSITY
OF DEFENSE TECHNOLOGY

Quick Overview

A single image

AR effect of object insertion into new scenes

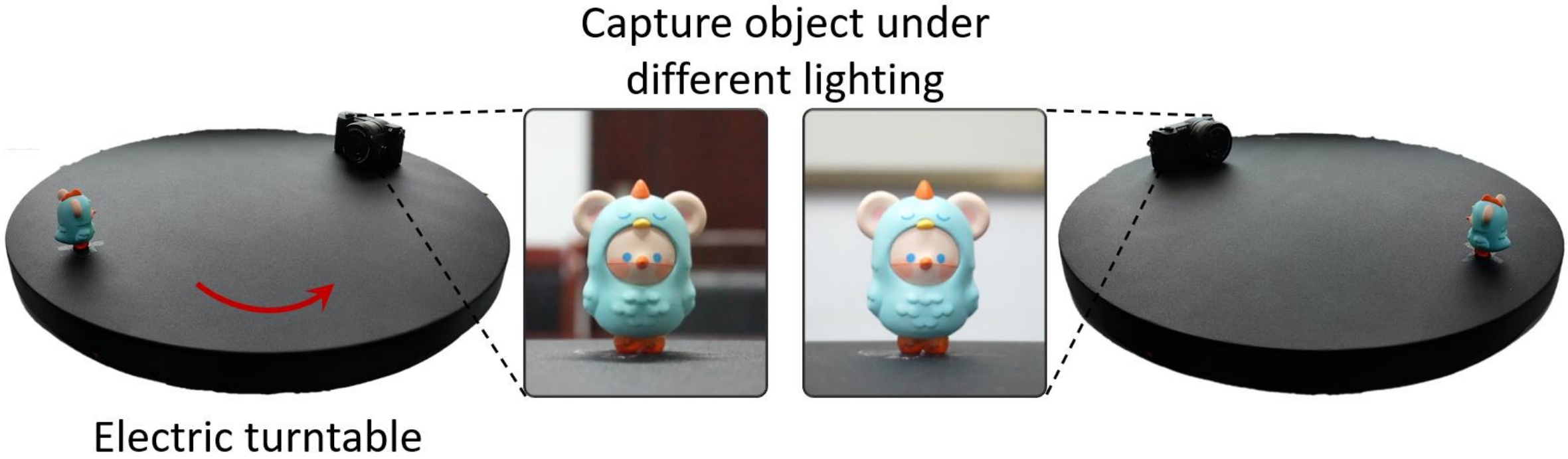
Quick Overview

- Inverse rendering + re-rendering

Challenges

- Inverse rendering from a single image is highly ill-posed
- Training data to solve inverse rendering or relighting is shorted
- Differentiable specular rendering layer based on parametric lighting models is shorted

Relit Dataset

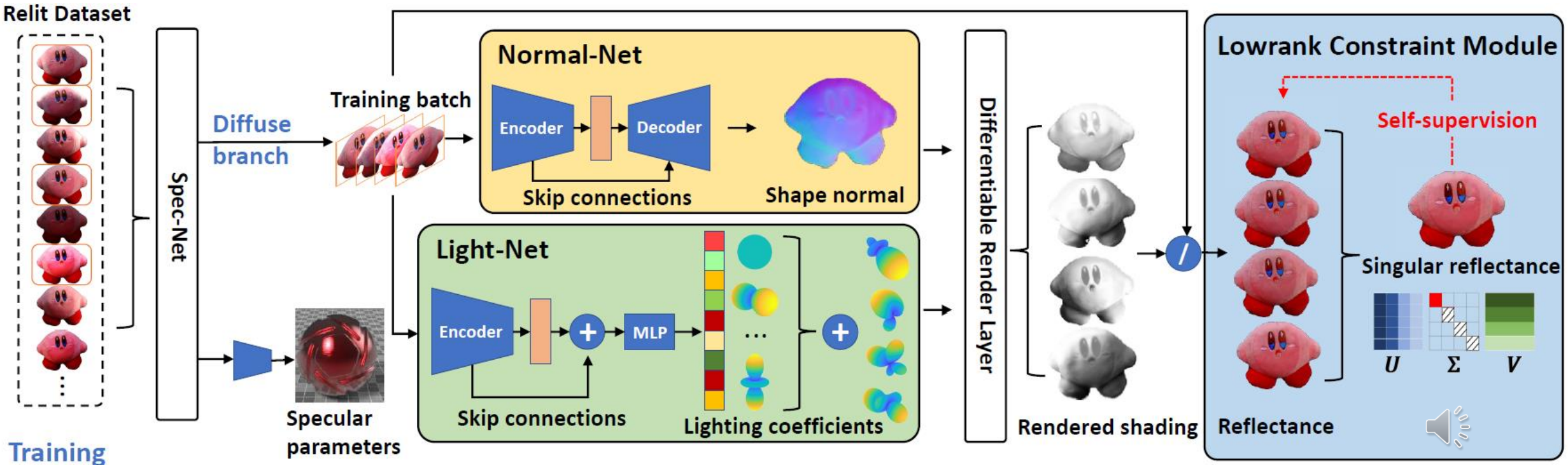


Relit Dataset

- 500 videos, 750K images

Weakly-supervised Inverse Rendering

- End-to-end self-supervised training



Loss definition and proofs

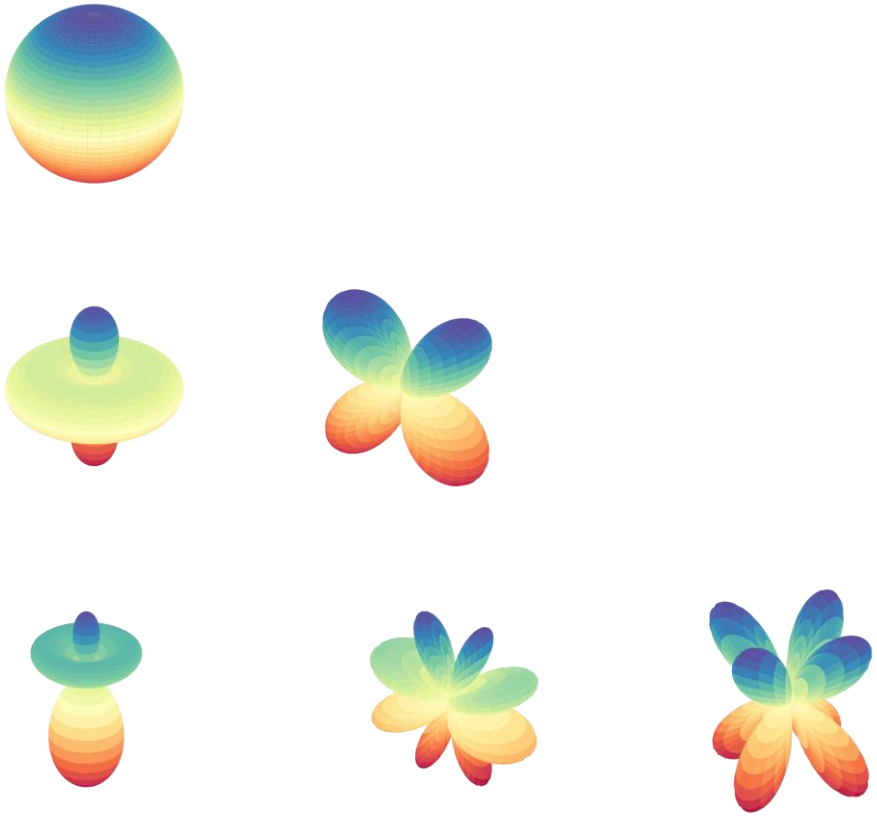
- Low rank loss:

$$f(R) = \|\bar{R} - R\|_F^2$$

- Theorem 1. $\bar{R}$ is the rank-one approximation of R. $\bar{R}$ is computed by: $R = U\Sigma V^T$ (SVD), $\Sigma = diag(\sigma_1, \sigma_2, \sigma_3, \dots), \Sigma' = diag(\sigma_1, 0, 0, \dots), \bar{R} = U\Sigma' V^T$.

- Theorem 2. Convergence of $f(R)$.

Differentiable Non-Lambertian Rendering



$$\hat{Y}_{0,0}(\theta,\phi) = Y_{0,0}(2\theta,\phi) = c_0$$
$$\hat{Y}_{1,1}(\theta,\phi) = Y_{1,1}(2\theta,\phi) = c_1 \sin 2\theta \cos\phi = 2c_1 xz$$
$$\hat{Y}_{1,-1}(\theta,\phi) = Y_{1,-1}(2\theta,\phi) = c_1 \sin 2\theta \sin\phi = 2c_1 yz$$
$$\hat{Y}_{1,0}(\theta,\phi) = Y_{1,0}(2\theta,\phi) = c_1 \cos 2\theta = c_1(2z^2 - 1)$$
$$\hat{Y}_{2,-2}(\theta,\phi) = Y_{2,-2}(2\theta,\phi) = 4c_2 xyz^2$$
$$\hat{Y}_{2,1}(\theta,\phi) = Y_{2,1}(2\theta,\phi) = c_2(4xz^3 - 2xz)$$
$$\hat{Y}_{2,-1}(\theta,\phi) = Y_{2,-1}(2\theta,\phi) = c_2(4yz^3 - 2yz)$$
$$\hat{Y}_{2,0}(\theta,\phi) = Y_{2,0}(2\theta,\phi) = c_3(3(4z^4 - 4z^2 + 1) - 1)$$
$$\hat{Y}_{2,2}(\theta,\phi) = Y_{2,2}(2\theta,\phi) = c_4(4x^2z^2 - 4y^2z^2)$$
$$c_0 = 0.282095, c_1 = 0.488603$$
$$c_2 = 1.092548, c_3 = 0.315392, c_5 = 0.546274$$

Spherical Harmonic bases for specular reflections.

Relighting Demos

Single object relighting

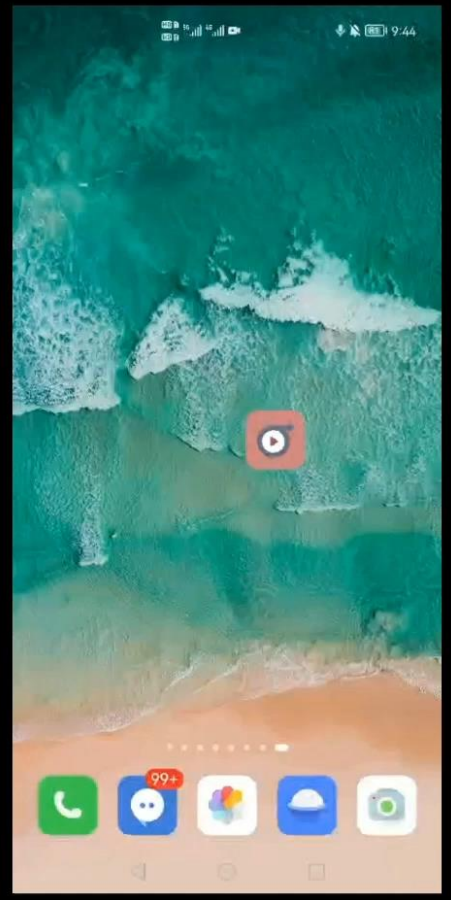
Our diffuse relighting

Naïve insertion (w/o relighting)

Mobile APP Demo

Live Recording

Screen Recording



Thanks for listening!

Please scan the barcode to check the project page with more info.