Using Near-Field Light Sources to Separate Illumination from BRDF

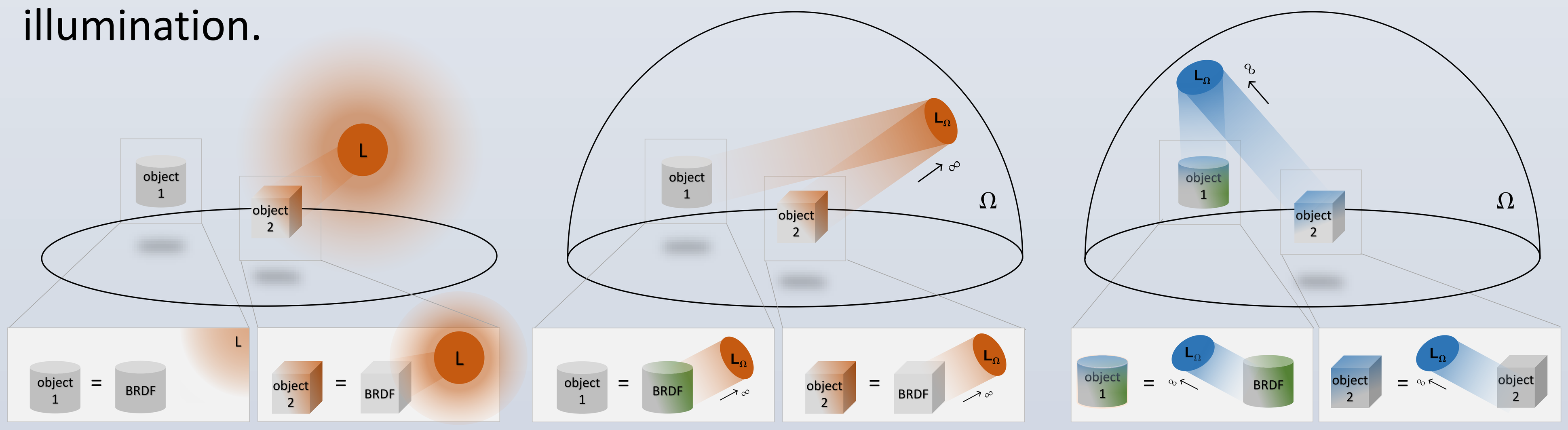
Jeroen Put Nick Michiels Philippe Bekaert

Hasselt University – tUL – iMinds – Expertise Centre for Digital Media, Belgium

{firstname.lastname}@uhasselt.be

Problem

Simultaneous estimation of lighting and BRDF (Bidirectional Reflectance Distribution Function) from multi-view images is an interesting problem in computer vision. It allows for exciting applications, such as flexible relighting in post-production, without recapturing the scene. The ability to alter scenes after they have been filmed has the potential to greatly reduce the number of costly recapturing iterations. Unfortunately, the estimation problem is made difficult because lighting and BRDF have closely entangled effects in the input images. Previous techniques are limited to distant lighting, whereas this paper presents an algorithm to support both the estimation of distant and near-field illumination.



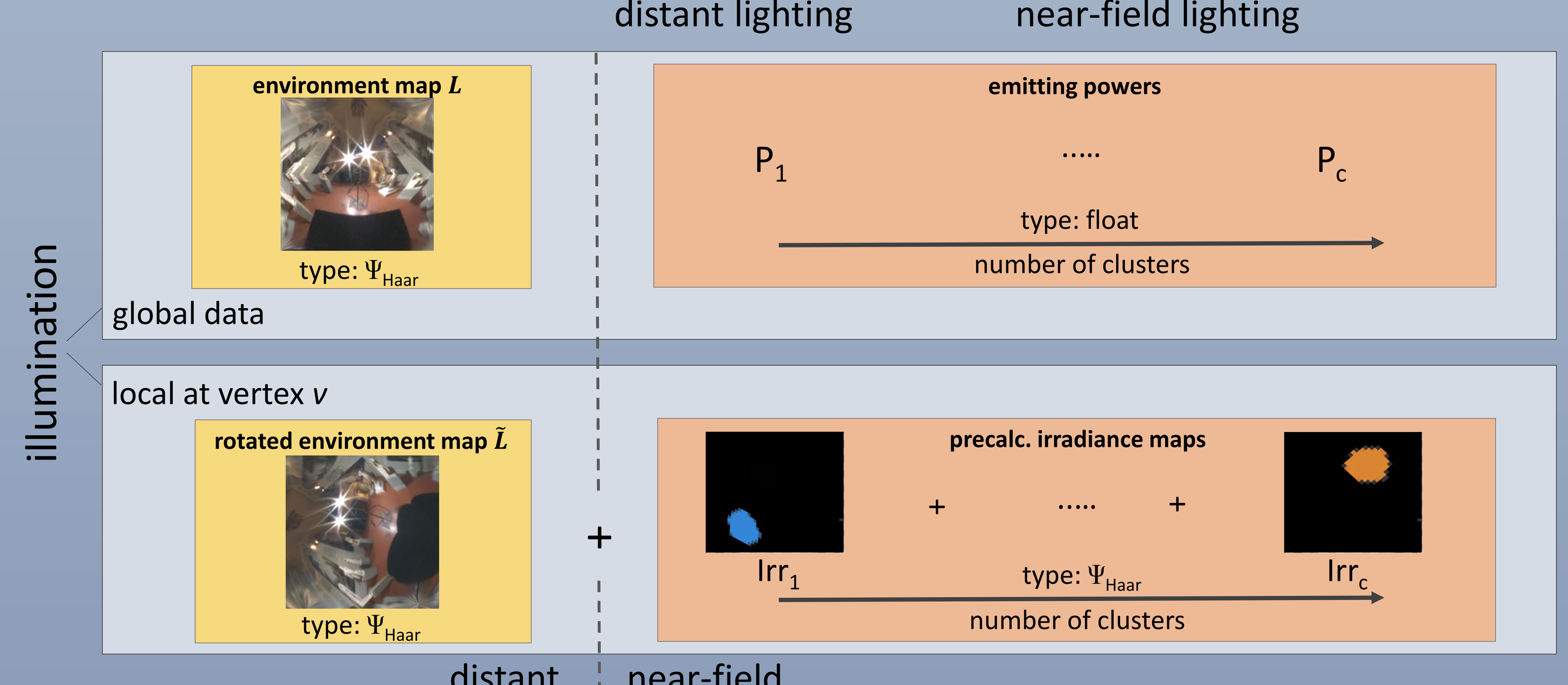
(left) A scene with 2 objects and a red local light source L. (middle) Current techniques model local lighting effects with distant light sources at infinity. This causes erroneous correction colors (shown here as green) in the BRDF. (right) Relighting reveals the wrongly estimated materials.

Contributions

- A factorization of illumination in distant and near-field lighting. This allows us to model local lighting effects, many of which are ignored by current methods
- A clean separation of distant and near-field lighting allows more accurate estimation of illumination and materials in a scene and permits the manipulation of local light sources. It also allows using knowledge of the light sources in a scene. For example, light source positions can be identified by a HDR clustering procedure and help improve the estimation of other factors.
- We formulate the problem so that the wavelet coefficients of the distant lighting environment map and the emitting powers of the near-field lighting can be solved together.
- We propose the use of clustering to group the most significant emitting triangles into dominant light sources. This grouping constrains the solver to more plausible solutions. We make the assumption that the distribution of light is roughly uniform along the emitting surface.

Factorization

$$B(v,\omega_o) = \underbrace{\sum_k \sum_l \sum_m C_{klm}\rho_k V_l \tilde{L}_m}_{\text{distant lighting}} + \underbrace{\sum_c \sum_k \rho_k (I_c P_c)}_{\text{near-field lighting}}$$



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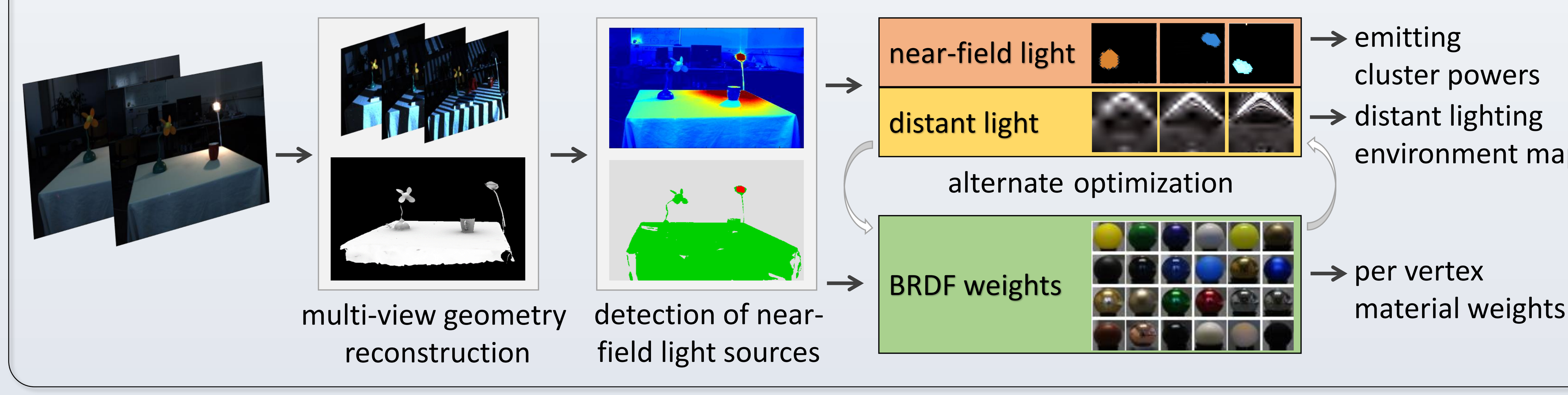
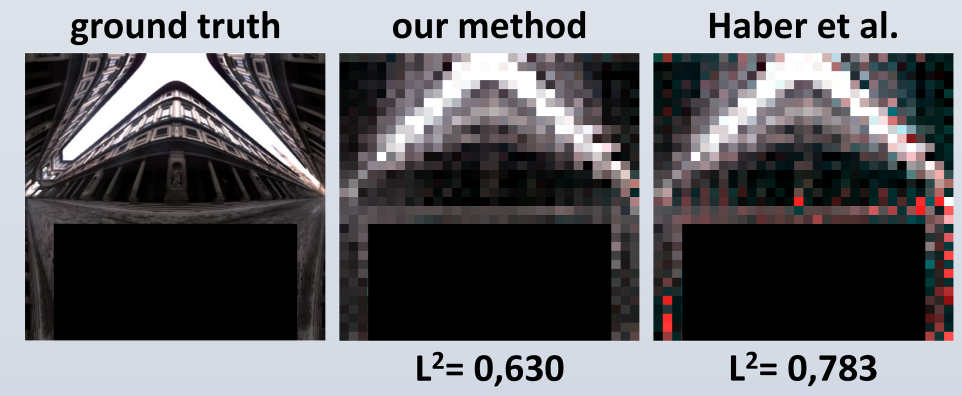
Overview

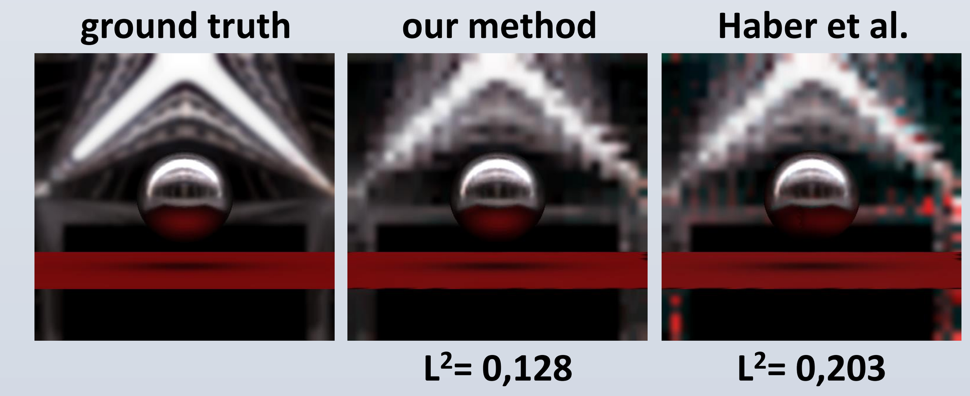


Results

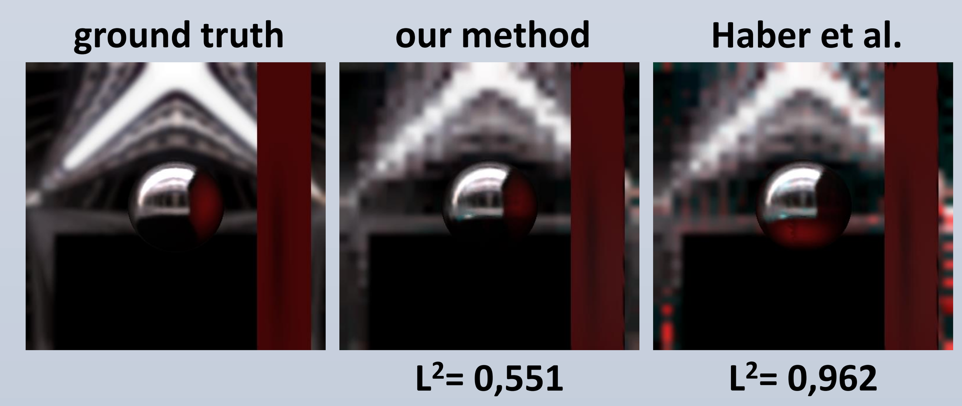
Synthetic Dataset



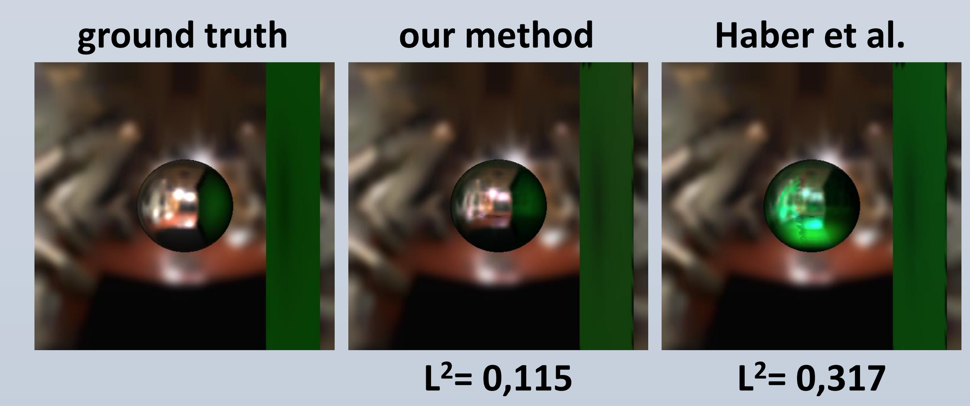
Estimated environment map. Note the spurious colors with the technique of Haber et al. (19,54% improvement).



Our method provides a more faithful reconstruction (36,95% improvement).

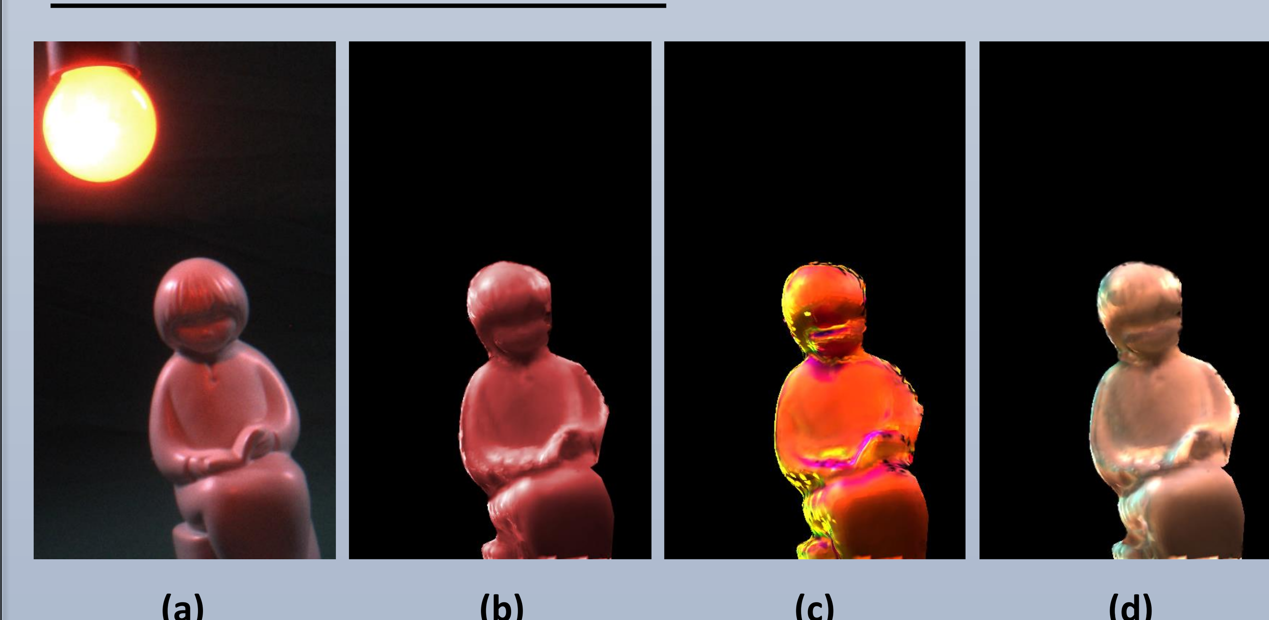


Change in near-field lighting position (red plane). Our technique can handle these near-field effects. Haber et al. models it as distant light (42,73% improvement).



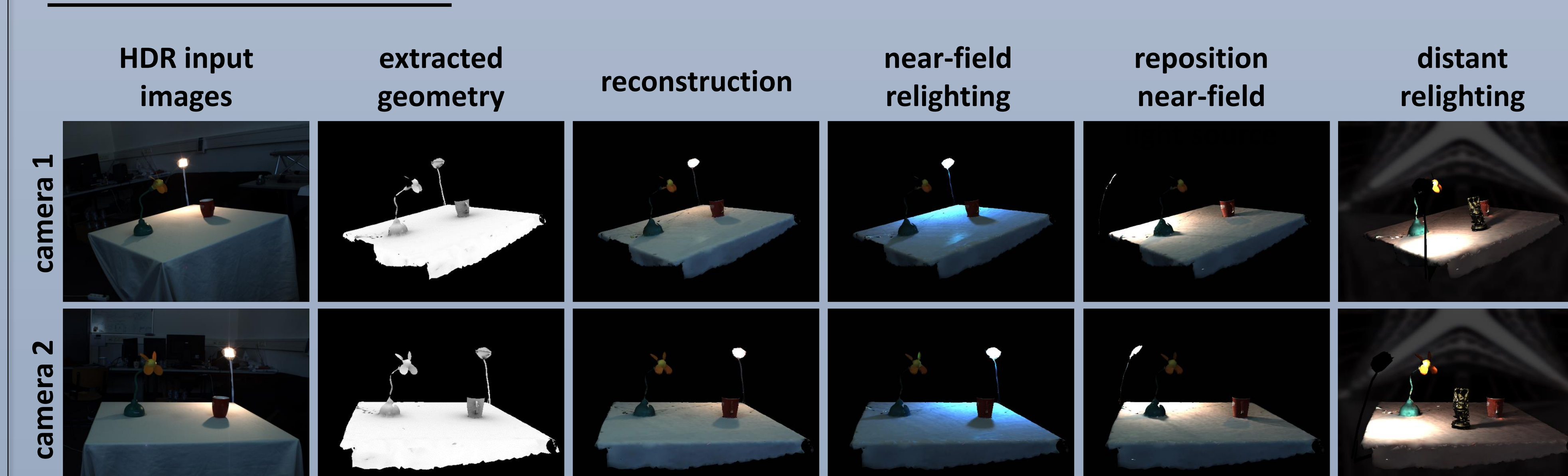
Change in near-field (green plane) and distant lighting (environment map). Our method reveals no erroneous correction colors in the BRDF (63,72% improvement).

Real Statuette Dataset



A white statuette under a red light source dataset.
a) One of the input images.
b) Reconstruction after optimization.
c) The technique of Haber et al. reveals compensation colors in materials when rendered under white lighting.
d) Material estimated by our technique rendered under white lighting.

Real Table Dataset



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