EUROPEAN CONFERENCE ON COMPUTER VISION

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MERLiN: Single-Shot Material Estimation and Relighting for Photometric Stereo

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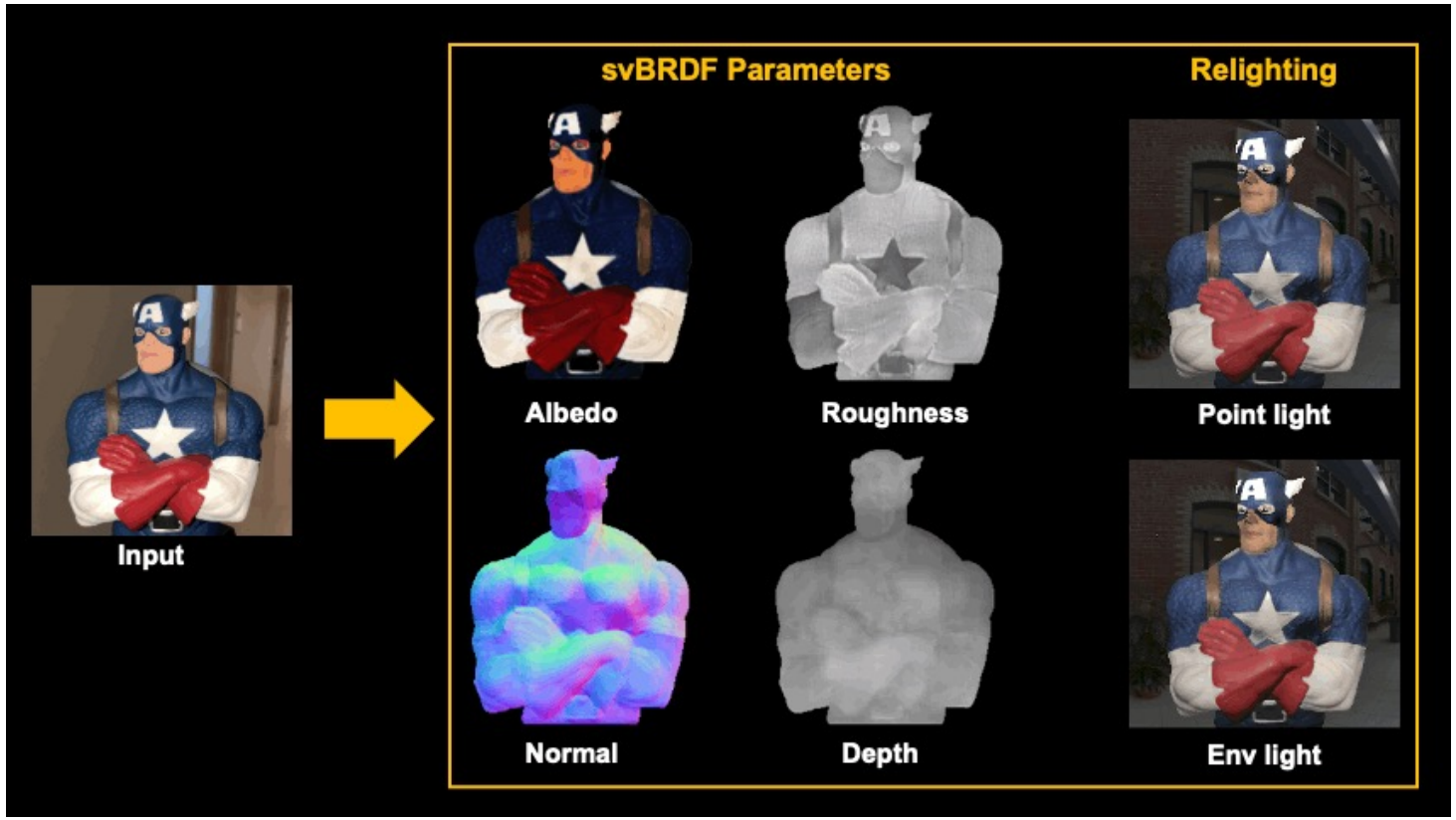
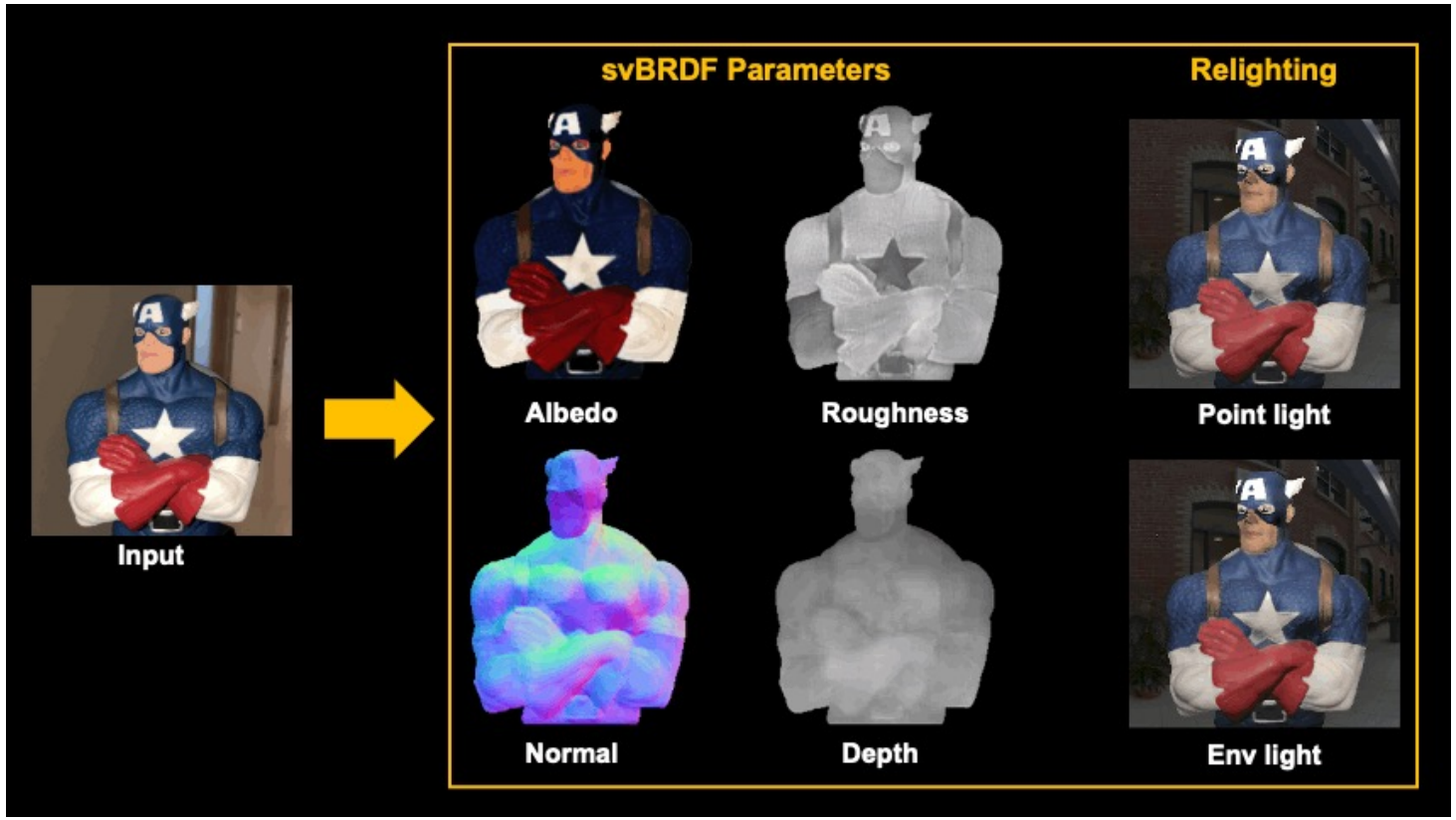
Objective

- MERLiN - **M**aterial **E**stimation and **R**e**Li**ghting **N**etwork
- A physically-based global illumination-aware deep network



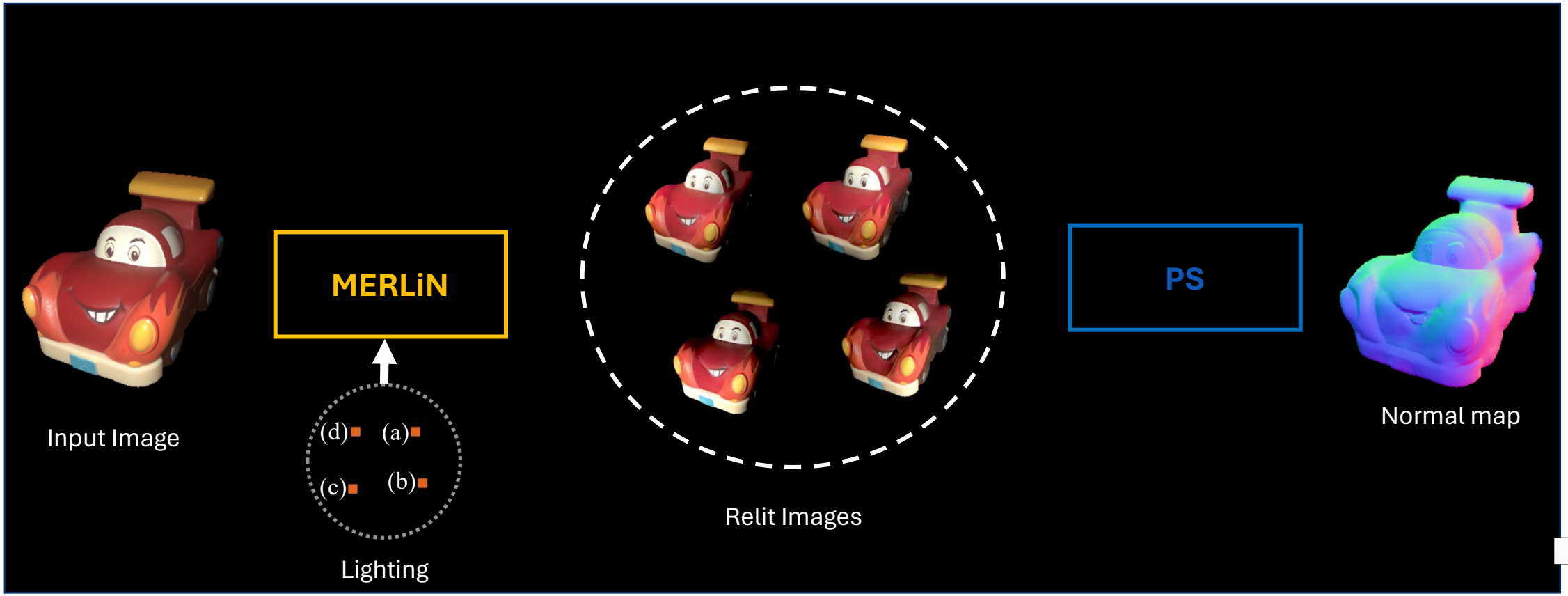
Objective

- Spatially varying bidirectional reflectance distribution function (svBRDF):
    - Diffuse albedo, normal, depth, and specular roughness
    - Jointly perform relighting through a single image.



Objective

- Compare the normal estimation accuracy using the relit images and their real counterparts.
- Take a step towards addressing photometric stereo from a single image via image-based relighting.

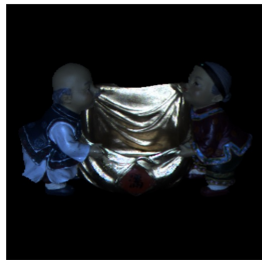


Background - Challenges

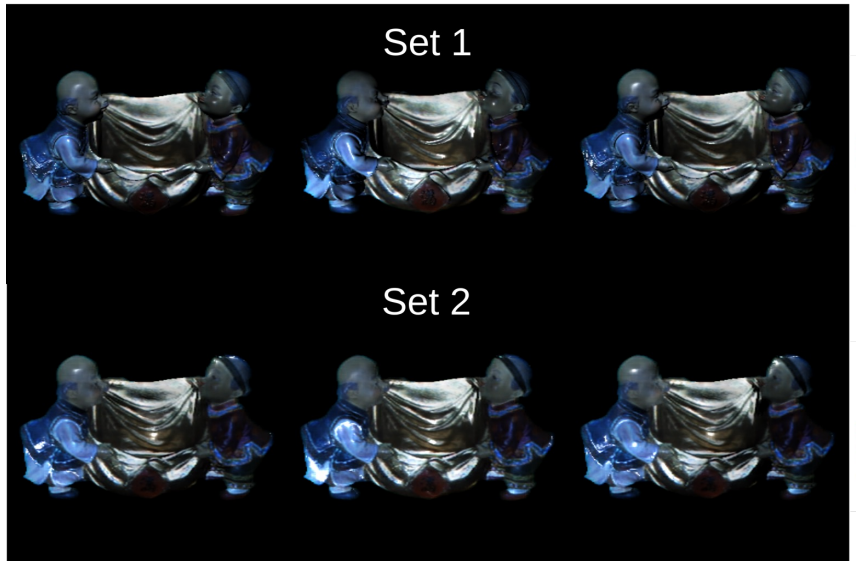
- Complex data acquisition
  - Carefully orchestrated setups with controlled lighting and precise calibration
- Exhaustive sampling of light space – infeasible
  - Time, cost, and memory overhead
- Insufficient or sub-optimal sampling through limited data

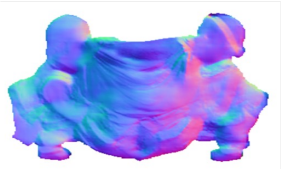
Key questions

- Can we leverage advancements in deep learning to generate differently illuminated images?
- Do these synthesized images always guarantee physical correctness?
- How can we validate the physical correctness of these relit images?



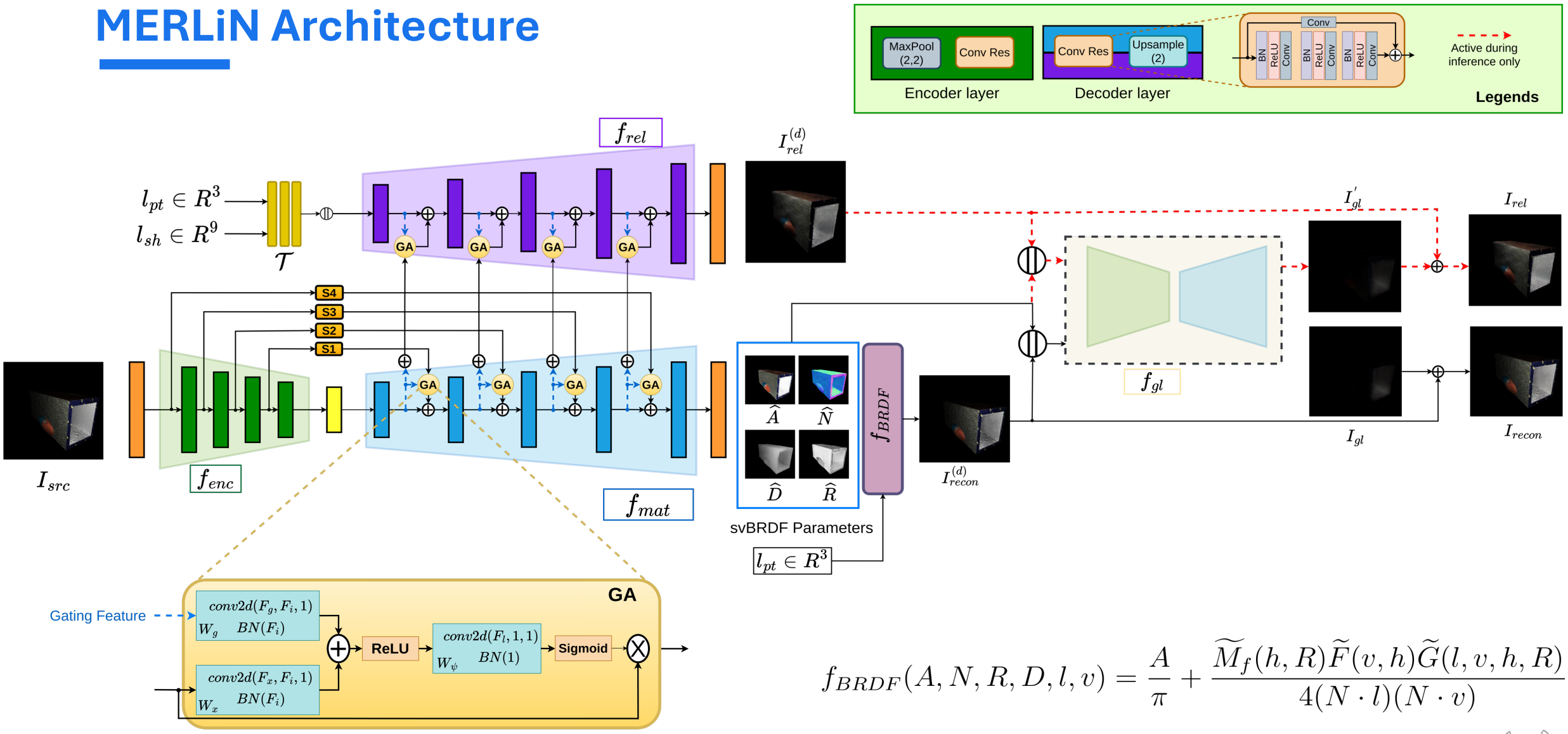
Source Image





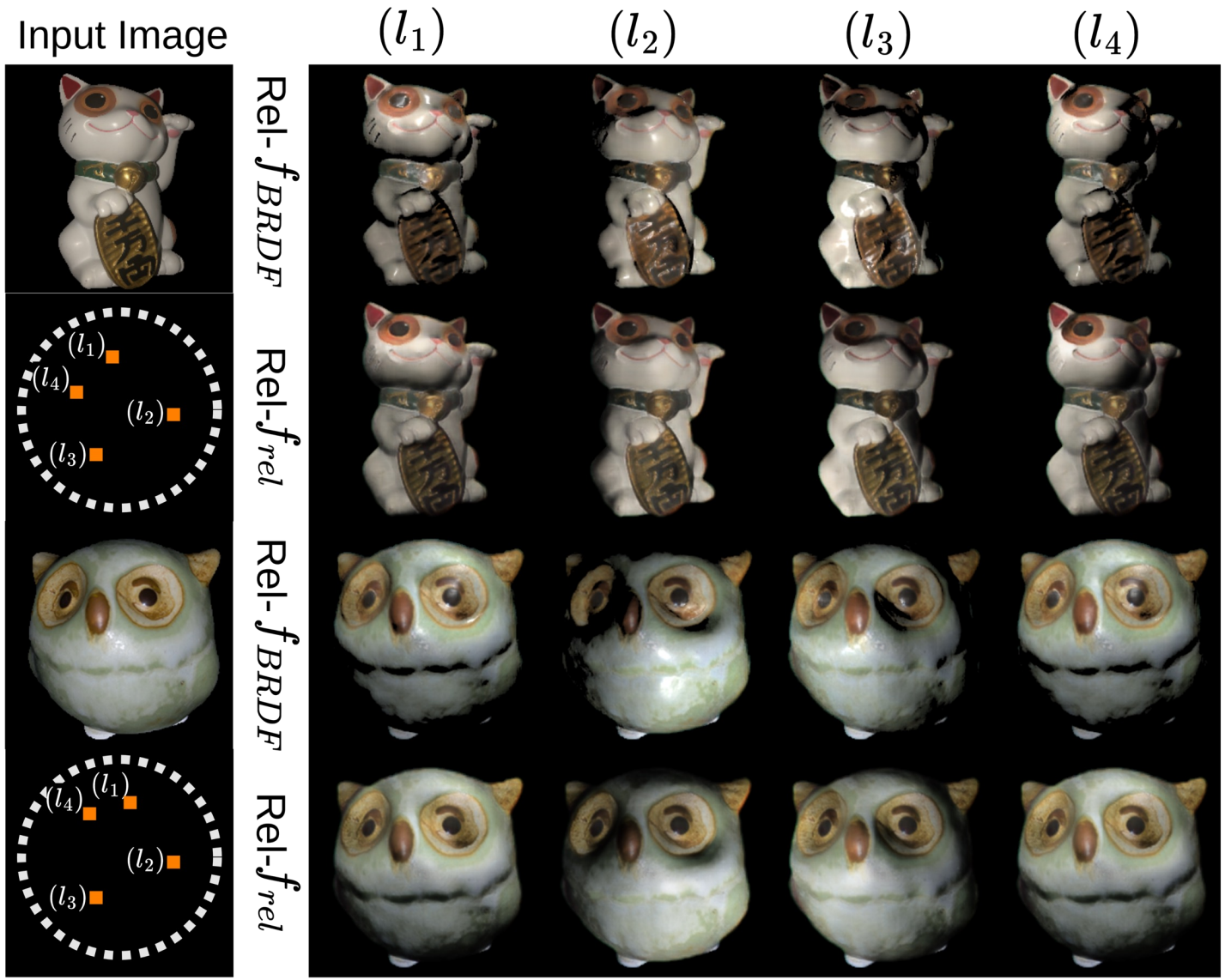
Normal map

MERLiN Architecture

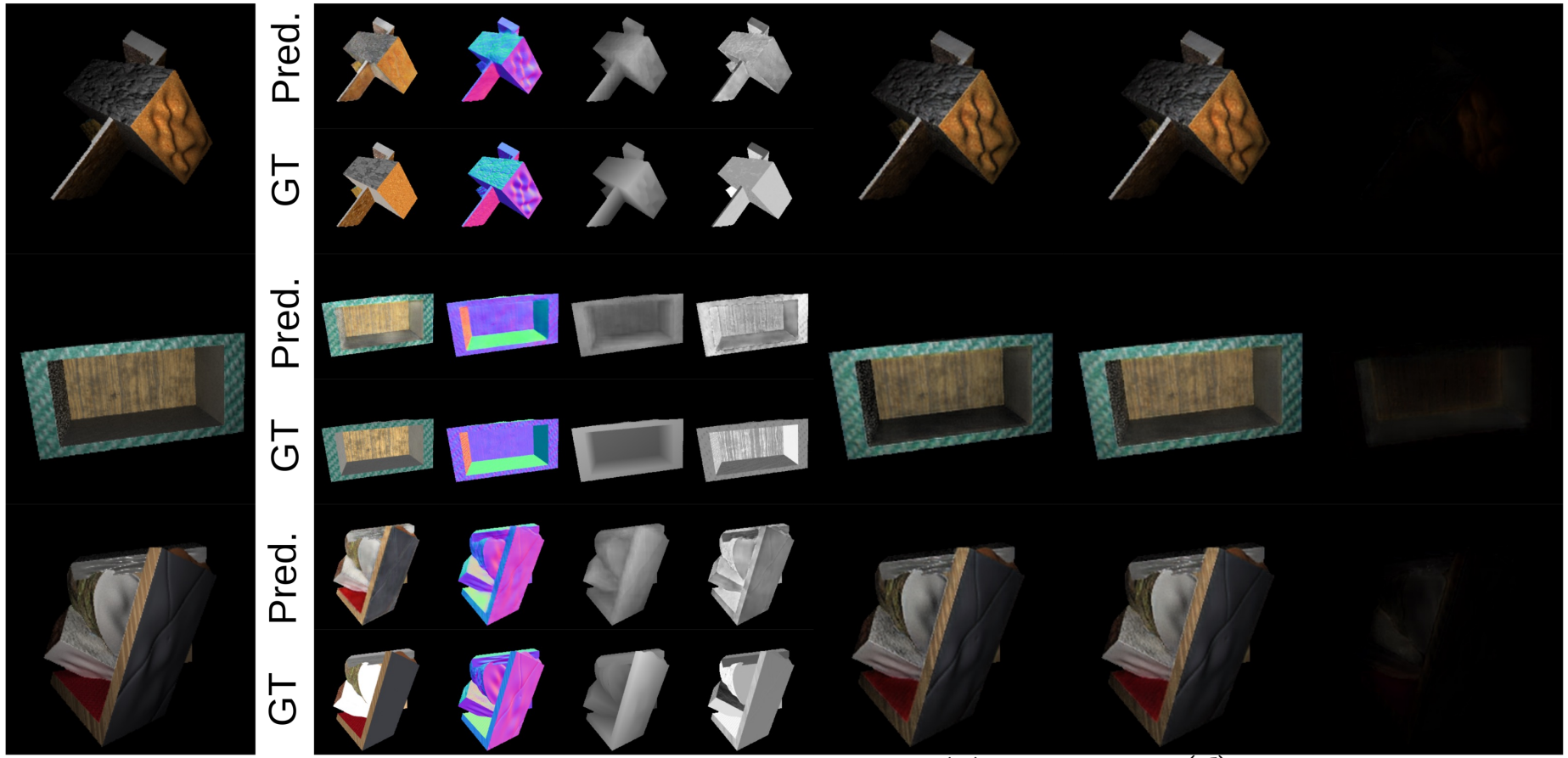


$$f_{BRDF}(A, N, R, D, l, v) = \frac{A}{\pi} + \frac{\widetilde{M}_f(h, R)\widetilde{F}(v, h)\widetilde{G}(l, v, h, R)}{4(N \cdot l)(N \cdot v)}$$

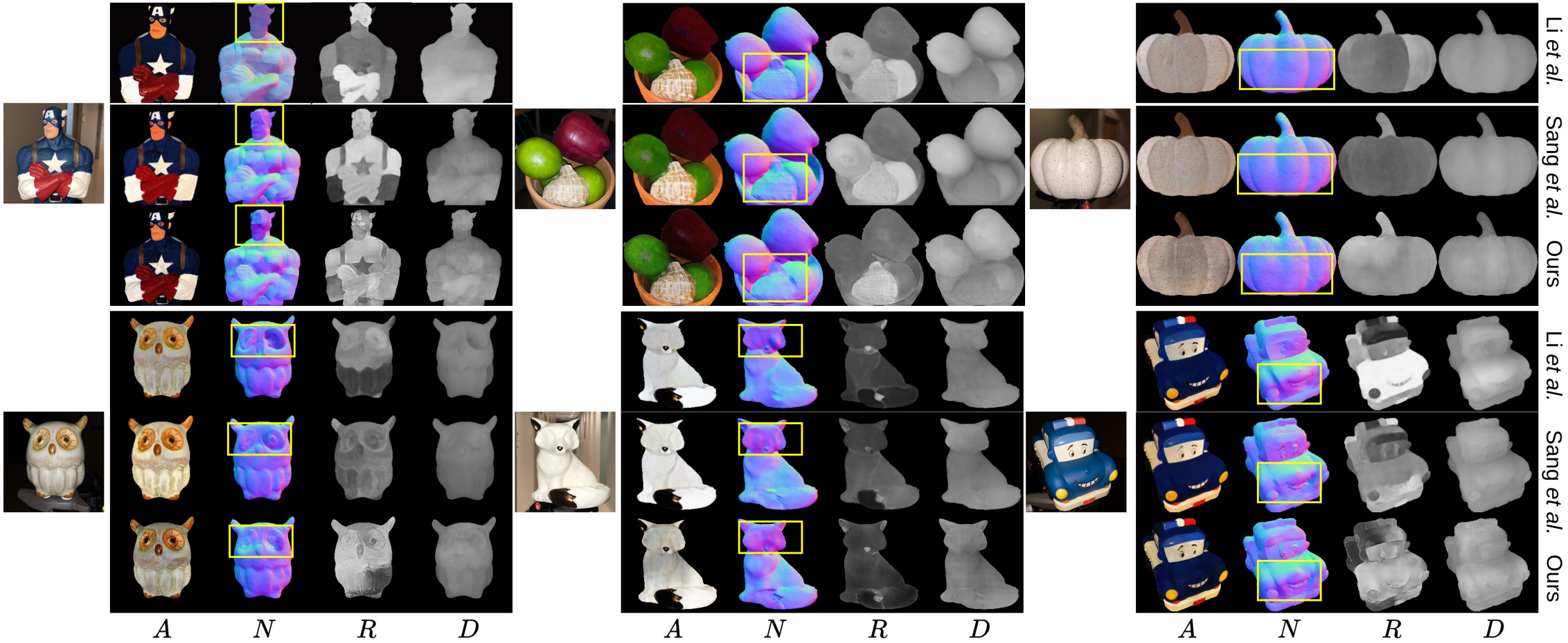
Relighting : f_{rel} vs f_{BRDF}



Global Illumination

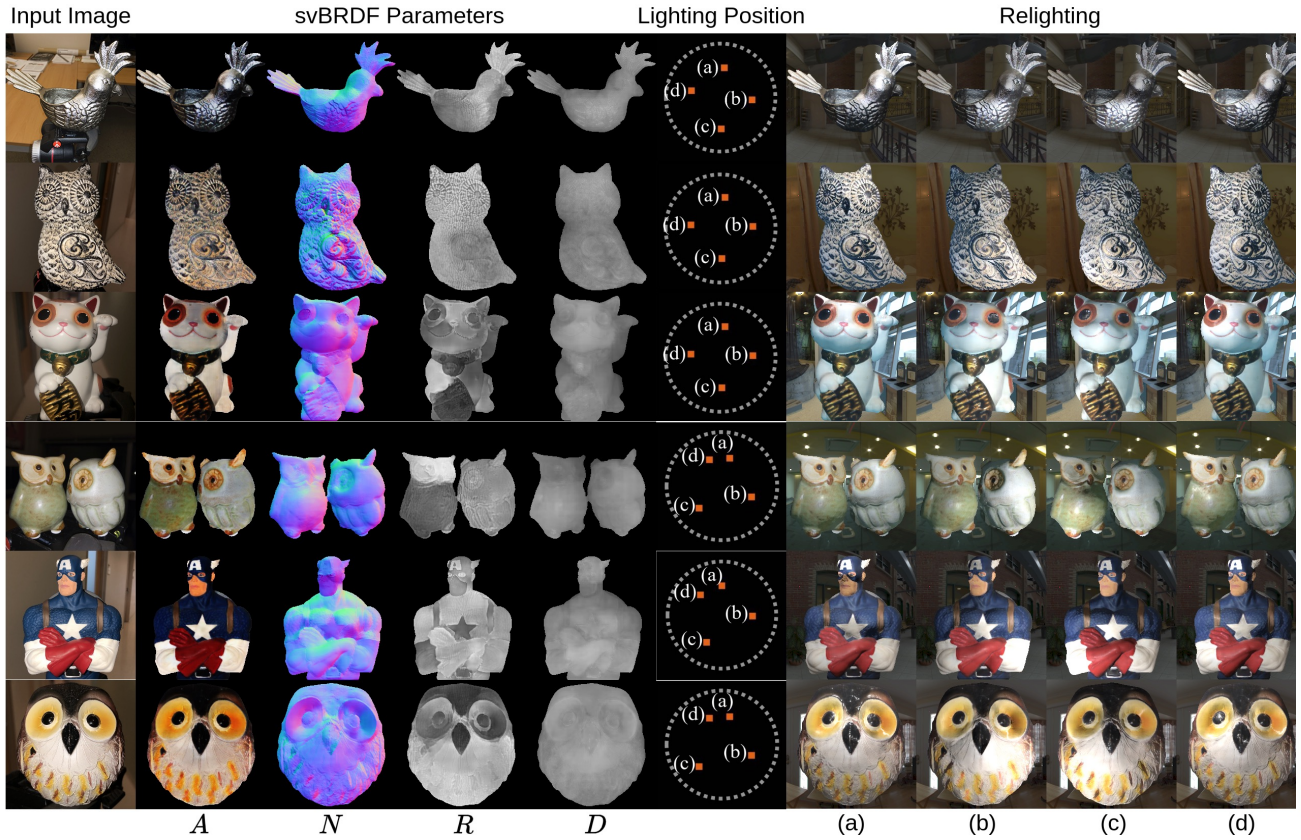


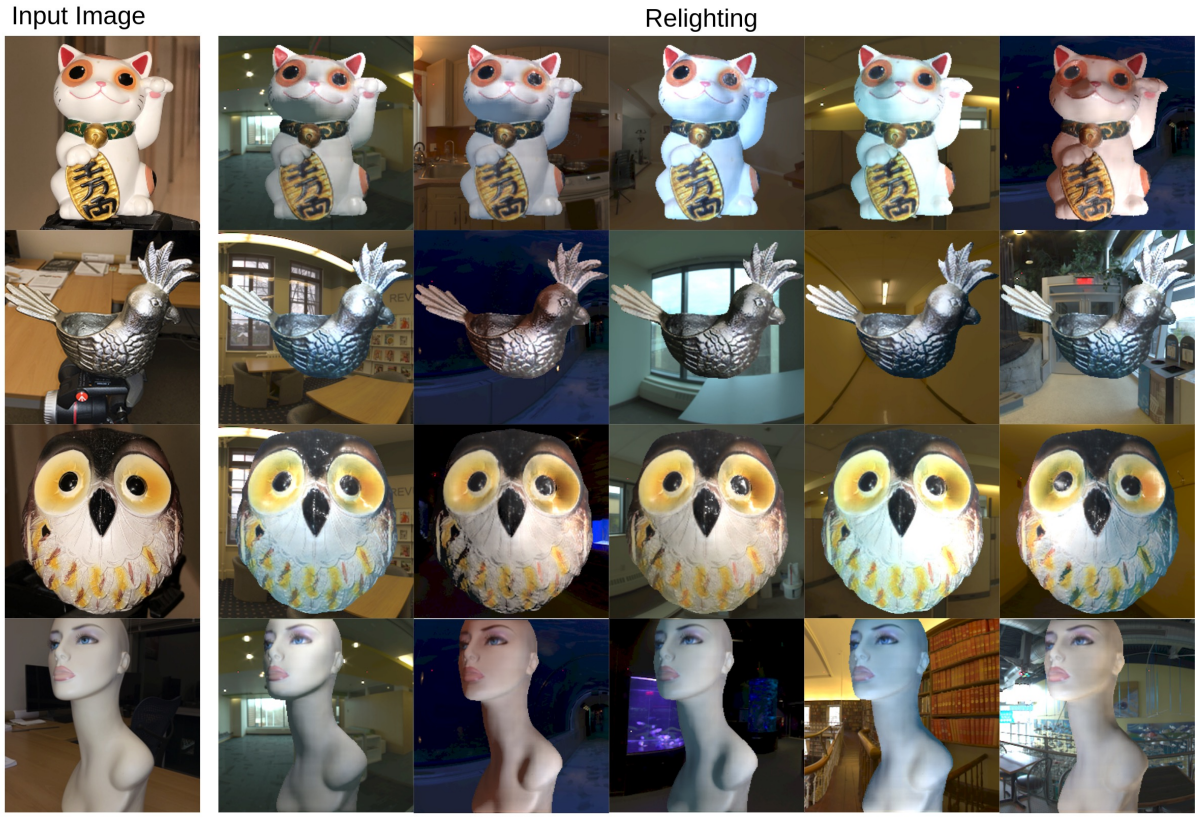
Results: svBRDF Estimation



Method	A	R	N	D	Relighting
Li *et al.* [22]	4.868	19.431	3.822	1.505	0.884
Sang *et al.* [34]	3.856	12.781	3.459	1.471	0.872
MERLiN (Ours)	**3.787**	**8.267**	**3.311**	**0.975**	**0.894**

Results: Relighting





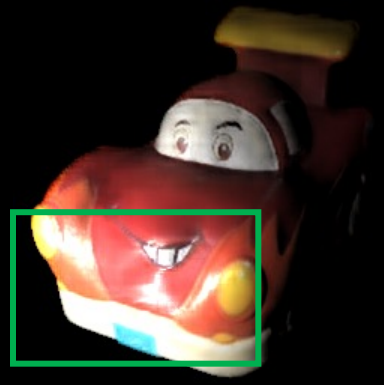
Results: Relighting

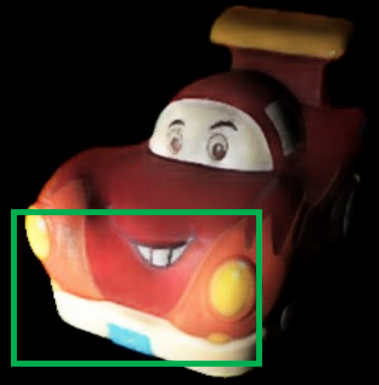
Input Image

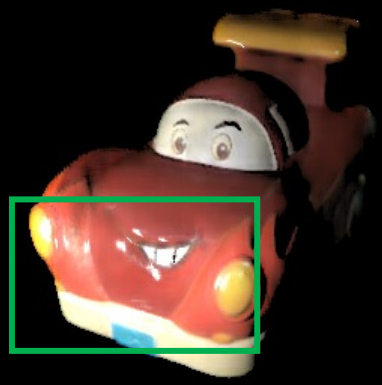
Li *et al.*

Sang *et al.*

MERLiN (Ours)







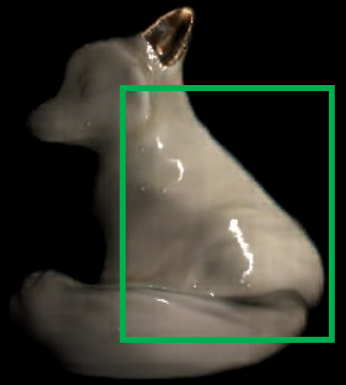
Results: Relighting

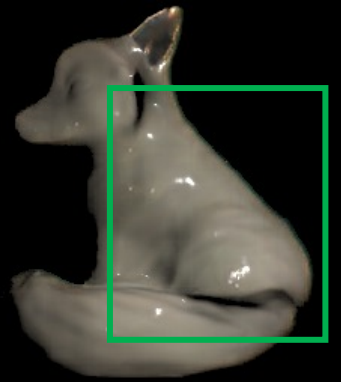
Input Image

Li *et al.*

Sang *et al.*

MERLiN (Ours)

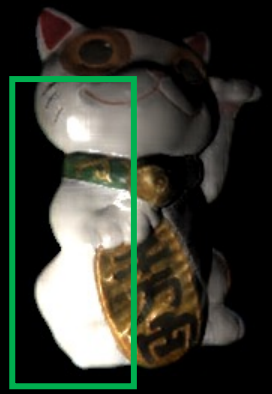




Results: Relighting

Input Image

Li *et al.*



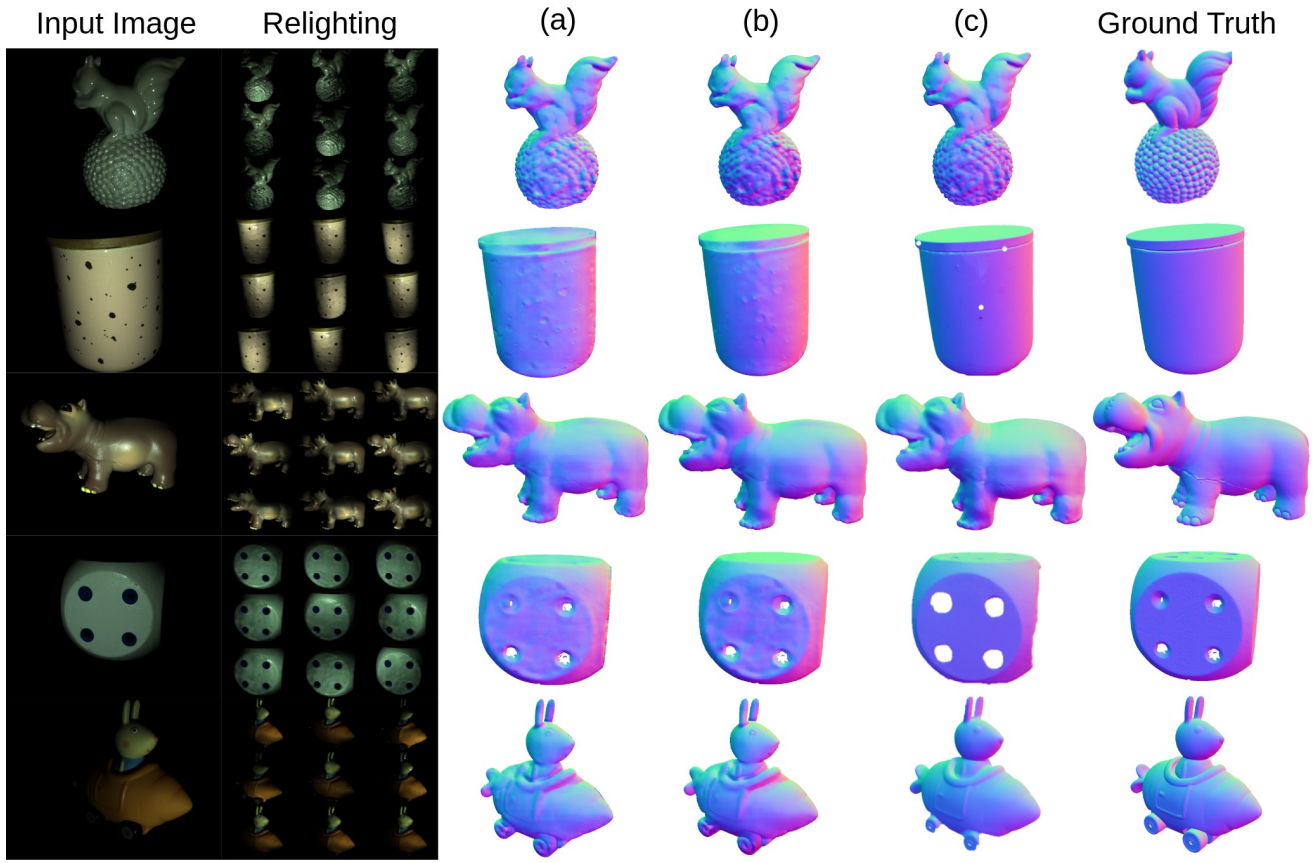
Sang *et al.*

MERLiN (Ours)

Results: Relighting

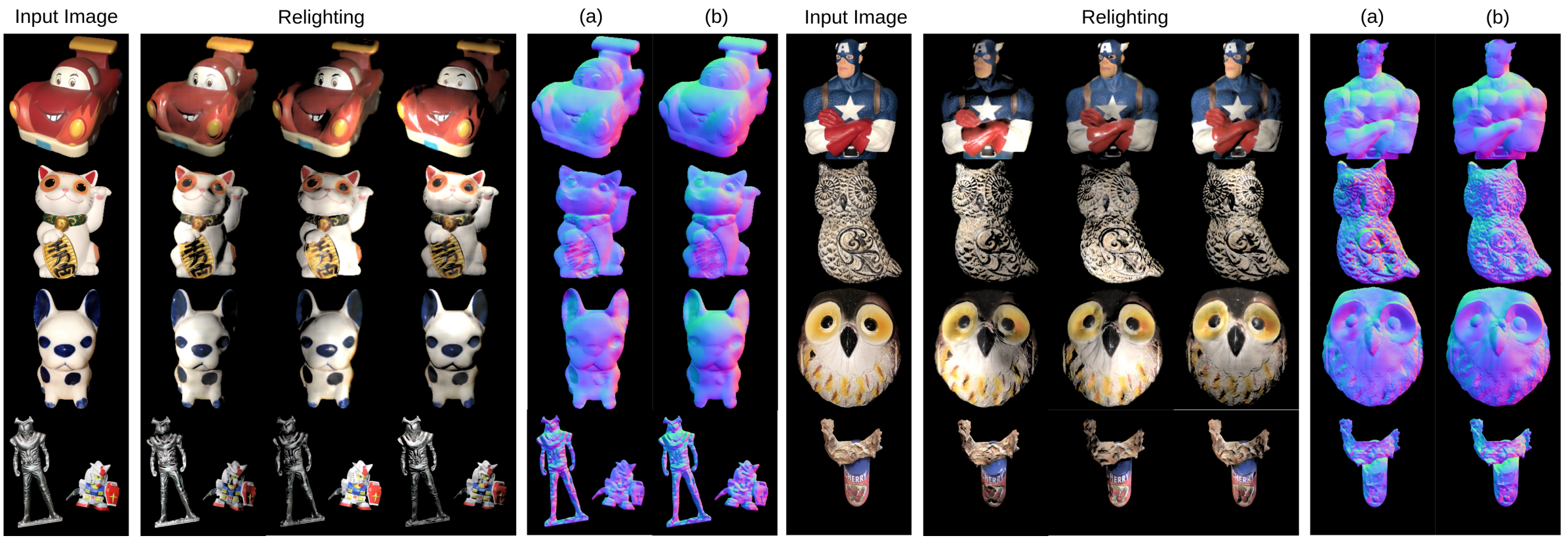
Photometric Stereo through Fast-NFPS [LUCES Dataset]

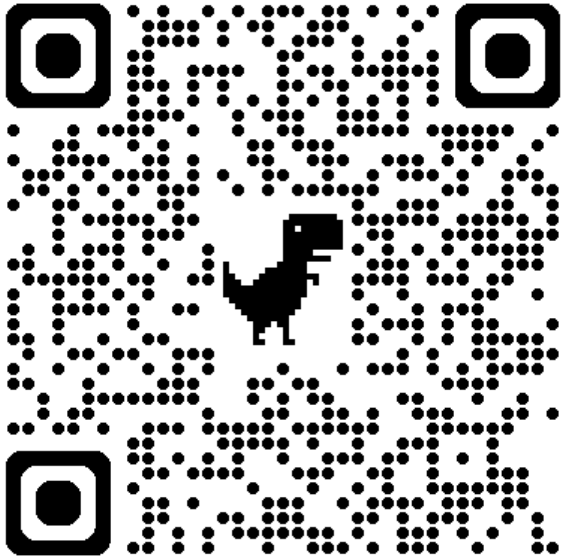
- Are the relit images physically correct?
- Are the normal estimates using multiple relit images better than those from a single image?
- How close are the results when compared to their real counterparts?



Input	Rel. Method	Bell	Ball	Buddha	Bunny	Die	Hippo	House	Cup	Owl	Jar	Queen	Squirrel	Bowl	Tool	Average
Single Image	-	12.03	10.75	21.26	12.02	9.51	11.23	40.16	19.68	17.62	9.37	20.93	19.94	12.79	21.59	17.06
32 Relit Images	Sang *et al.* [34]	10.09	9.52	19.17	12.69	9.21	10.08	39.42	19.59	17.29	9.79	22.19	19.67	11.96	19.29	16.43
	Li *et al.* [22]	10.33	9.89	18.96	12.03	10.04	10.11	36.88	19.34	16.17	10.51	21.31	19.32	12.23	19.77	16.21
	MERLiN (Ours)	9.51	9.12	18.27	**11.71**	9.12	**10.02**	36.91	19.27	16.97	9.82	20.18	19.05	11.98	19.31	15.8[illegible]
32 Real Images	-	**7.17**	**6.59**	**14.50**	11.89	**8.63**	10.64	**31.00**	**18.98**	**15.92**	**9.14**	**18.39**	**18.26**	**10.17**	**18.61**	**14.11**

Photometric Stereo through SDM-UniPS [Smartphone Images]





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Thank you!