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

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1 Relighting Results

We have compiled the results on relighting in a video showing the comparison between Li *et al.* [2], Sang *et al.* [3], and MERLiN (Ours). We show the results under point lighting, environment lighting, and point + environment lighting. We observe the change of specular highlights when rotating the point light source and the environment maps, which shows that spatially varying roughness has been successfully captured by the network. Moreover, we observe that Li *et al.* [2] models the specularities slightly better than Sang *et al.* [3], but it spreads the specularities over a larger area and also produces saturating effects (as shown in the regions highlighted in the green box). The relit images generated by MERLiN appear more realistic and physically plausible. We do not have ground truth images under respective lighting for real data. However, the realistic changes in shading and specular highlights while rotating light sources could be observed to appreciate the relighting performance.
The video can be found at: https://sites.google.com/iitgn.ac.in/merlin

2 BRDF Model

We use the microfacet BRDF model described in [1]. Given the diffuse albedo (A), specular roughness (R), normals (N), and depth (D) along with l, v, and h being the light direction, viewing angle, and the half-angle between them, the BRDF (f_{BRDF}) can be characterized as per Equation 1.

$$f_{BRDF}(A, N, R, D, l, v) = \frac{A}{\pi} + \frac{\widetilde{M_f}(h, R)\widetilde{F}(v, h)\widetilde{G}(l, v, h, R)}{4(N \cdot l)(N \cdot v)} \tag{1}$$

Here, $\widetilde{M_f}(h, R)$, $\widetilde{F}(v, h)$, and $\widetilde{G}(l, v, h, R)$ are the microfacet distribution, Fresnel, and geometry term. The distribution term describes the distribution of surface normals representing the probability density function of the microfacet normals oriented along the direction. The Fresnel term accounts for how much light is

reflected versus refracted at the interface between two media, and the geometry term accounts for occlusion between microfacets.

Each term in Equation 1 is defined as follows.

$$\widetilde{M}_f(h,R) = \frac{\alpha^2}{\pi[(N\cdot h)^s(\alpha^2-1)+1]^2}$$

$$\alpha = R^2$$

$$\widetilde{F}(v,h) = (1-F_0)2^{-[5.55473(v\cdot h)+6.8316](v\cdot h)}$$

$$\widetilde{G}(l,v,h,R) = \widehat{G}_1(v,N)\widehat{G}_1(l,N)$$

$$\widetilde{G}_1(v,N) = \frac{N\cdot v}{(N\cdot v)(1-k)+k}$$

$$\widetilde{G}_1(l,N) = \frac{N\cdot l}{(N\cdot l)(1-k)+k}$$

$$k = \frac{(R+1)^2}{8}$$

$$F_0 = 0.05$$

References

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