Supplementary Materials for
"Symmetric-light Photometric Stereo"

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To further assess the proposed method, in this supplementary material,

A. we show estimation accuracies with varying elevation angles of the light directions,
B. we evaluate the proposed method under a near-light setting,
C. we evaluate the proposed method with non-Lambertian scenes,
D. we show the estimation results on the DiLiGenT dataset using different sets of light directions.

A. Synthetic experiments with varying the elevation angles of light directions

In Sec. 5.1 in the main paper, we only show the comparison for the scenes rendered under the fixed light directions. Figure S.1 shows the estimation results for a sphere scene with varying the elevation angles of the light directions from 55 to 80 [deg.]. The sphere has the Lambertian surface and is rendered without the global-illumination effects. The smaller elevation angles naturally bring the larger estimation errors in both the proposed method and the comparison method, Calibrated, due to the effect of shadows. The overall results demonstrate that the proposed method is independent of the elevation angles of the light directions.

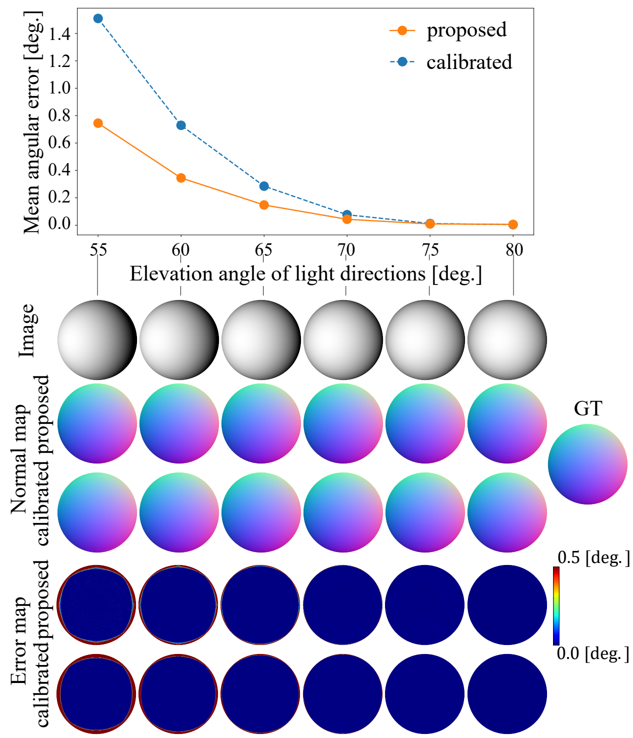

Figure S.1: Estimation results of the sphere scene with varying elevation angles of the light directions. The plots of the mean angular errors in degrees are shown on the top of the input images, estimated normal maps, and corresponding error maps.

B. Effect of near-light settings

The proposed method assumes distant-light settings, which means point light sources are placed infinitely far away from a scene. However, in realty, there are many setups that are a near-light setting. We thus evaluate the proposed method under a near-light setting. For the evaluation, we render a Lambertian sphere with varying the distance between the target object to light sources. The radius of the sphere is 1 [m] and is placed 5 [m] away from the camera. Figure S.2 shows the estimation results and the plots of the mean angular errors. When the light sources are placed farther than about 8 [m], the proposed and comparison methods show almost the same accuracy with the distant-light setting. As the distance between the target and light sources becomes smaller, the proposed method is affected by the near-light effect. Since the proposed method uses a pixel pair for surface normal estimation, when all pixels have systematic errors affected by the near-light, the proposed method starts to exhibit larger errors compared to methods that works in a per-pixel manner.

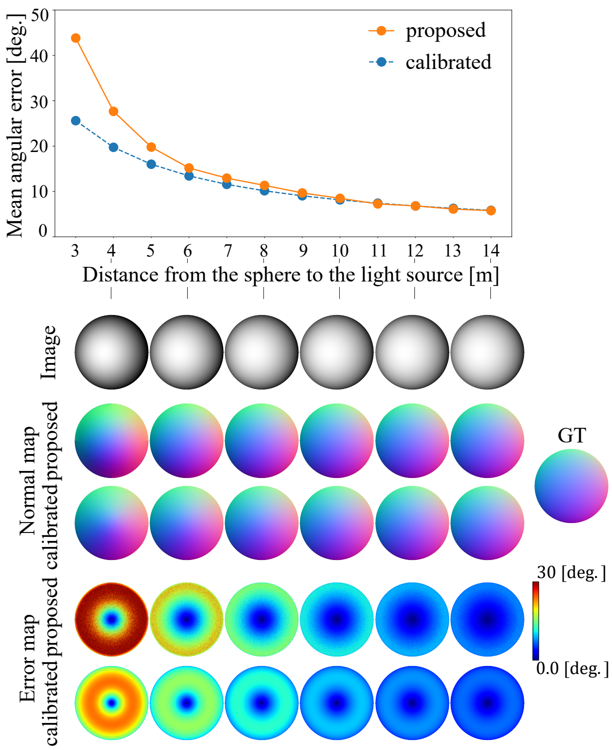

Figure S.2: Estimation results of the sphere scene under the near-light settings. The plots of the mean angular errors in degrees are shown on the top of the input images, estimated normal maps, and corresponding error maps.

C. Effect of non-Lambertian reflectance

We evaluate the proposed method with non-Lambertian scenes. We use a sphere scene with a non-Lambertian diffuse reflectance model, the Oren-Nayar model [2]. The light directions are the same as Sec. 5.1 in the main paper. Figure S.3 shows the estimation results with varying the roughness. Since the proposed and comparison methods assume the Lambertian surface, the estimation errors increase for both methods as the effect of roughness becomes stronger. As discussed in Sec. B, since the deviation of the Lambertian assumption by the non-Lambertian surface uniformly affects all pixels, the proposed method exhibits larger errors than the comparison method.

D. Results for DiLiGenT dataset

From the 96 light directions in the DiLiGenT dataset, we use one set of four light directions for the symmetric-light photometric stereo in Sec. 5.2 in the main paper. Here, we show the estimation results using different sets of approximately symmetric lights.

Figure S.4 shows the three sets of four light directions,

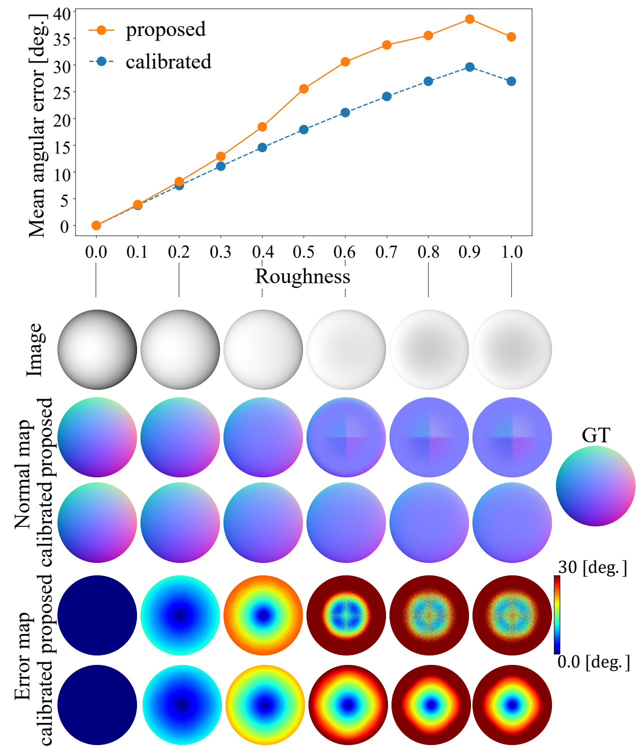

Figure S.3: Estimation results of the sphere scene with varying roughness. The plots of the mean angular errors in degrees are shown on the top of the input images, estimated normal maps, and corresponding error maps.

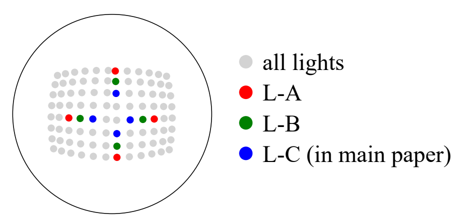

Figure S.4: Visualization of the light directions in the DiLiGenT dataset. We choose three sets of light directions that are roughly symmetric. L-C is used in the main paper.

L-A, L-B, and L-C, where L-C corresponds to the set used in the main paper (illustrated in Sec. 5.2 in the main paper). Figure S.5 shows the estimation results under L-A and L-B. The proposed method shows consistent results to ones shown in Fig. 4 in the main paper. For the BEAR scene under L-A, both methods exhibit significantly larger errors compared to L-B and L-C. This is due to the fact that one of the four images in the BEAR scene contains error as discussed in [1].

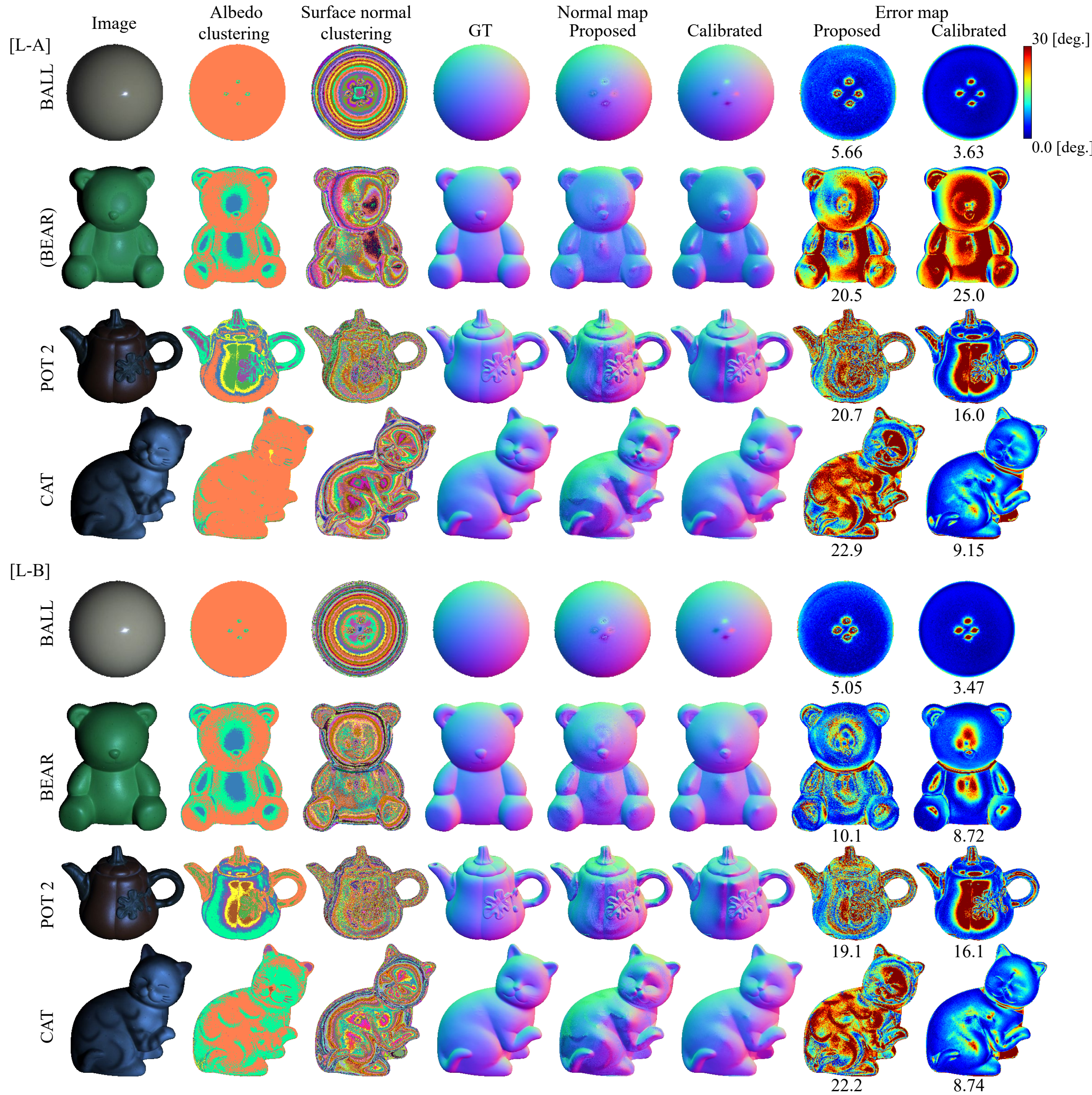

Figure S.5: Estimation results for the DiLiGenT dataset under the two sets of light directions, L-A and L-B. For each row, we show one of the input images, results of albedo and surface normal clustering, the ground-truth and estimated normal maps for each method, and corresponding error maps. For each error map, we show the mean angular errors in degrees. Note that the BEAR scene under L-A contains error, resulting in significant estimation errors for both methods.

References

[1] Satoshi Ikehata. CNN-PS: CNN-based photometric stereo for general non-convex surfaces. In *Proceedings of European Conference on Computer Vision (ECCV)*, pages 3–18, 2018.

[2] Michael Oren and Shree K. Nayar. Generalization of Lambert's reflectance model. In *Proceedings of SIGGRAPH*, pages 239–246, 1994.