Supplementarl Materials: Efficient Multi-View Inverse Rendering Using a Hybrid Differentiable Rendering Method

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1 Details of Geometry Optimization

We follow the approach in [Liu *et al.*, 2019] to compute the silhouette of a given mesh from a specific view direction. Specifically, for each face f_j, we define a differentiable probability map $\mathcal{D}_j$ that describes its influence in the image plane. The value of $\mathcal{D}_j$ at a pixel i is computed as

$$\mathcal{D}_j^i = \text{sigmoid}\left(\delta_j^i \cdot \frac{d^2(i,j)}{\sigma}\right), \tag{1}$$

where σ is a positive scalar parameter controlling the sharpness of the probability distribution (we set it to 1×10^{-4} in our experiments), $d(i,j)$ is the closest Euclidean distance from p_i to the edges of f_j's projection $\widetilde{f_j}$ onto the image plane, and δ_j^i is a sign indicator

$$\delta_j^i = \begin{cases} +1 & \text{if } p_i \text{ is inside } \widetilde{f_j}, \\ -1 & \text{otherwise.} \end{cases}$$

A differentiable silhouette is then computed using the probability maps for all the mesh faces. The value of the silhouette at a pixel p_i is computed as

$$I_s^i = 1 - \prod_j (1 - \mathcal{D}_j^i).$$

2 Experiments and Demos

2.1 Further Ablation Study

We test removing the geometry optimization from our pipeline. As shown in Fig. 1, the resulting reconstructions have much poorer quality around the boundary, e.g., the hotdog. Specifically, For the flat data like hotdog, there can be some defects in the boundary regions leading to a serious decline in the metrics. For the pomegranate and lemon, although the visual effect is not obvious, there are also some problems at the boundary, which can be reflected in the metrics. In comparison, the use of geometry optimization can make the resulting geometry more reasonable. Therefore, our approach combining geometry optimization and reflectance optimization can produce better reconstruction results.

2.2 Video Demos

Some video demos can be found in the demo folder. There are three test models, placed in three separate subfolders. Each subfolder contains three video clips for the same model: one for novel view synthesis, and the other two for relighting results under different environment lighting conditions.

References

[Liu *et al.*, 2019] Shichen Liu, Tianye Li, Weikai Chen, and Hao Li. Soft rasterizer: A differentiable renderer for image-based 3d reasoning. In *Proceedings of the IEEE/CVF International Conference on Computer Vision*, pages 7708–7717, 2019.

Figure 1: Ablations on our geometry optimization phase. The column 'W/O GO & RO' contains results without geometry optimization and reflectance optimization. The column 'W/O GO' contains results without geometry optimization.