Polarimetric Relative Pose Estimation Supplementary Material

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In the supplementary material, we illustrate the definitions of surface normal related angles, and provide more experimental results.

1. Illustration of Azimuth and Zenith Angles

In this section, we illustrate the definition of azimuth and zenith angles. As it is shown in Figure 1, the azimuth angle φ is defined as the angle between the direction of the projected surface normal and x-axis in the image coordinates. The zenith angle θ is defined as the angle between the surface normal of the 3D point and the negative viewing direction.

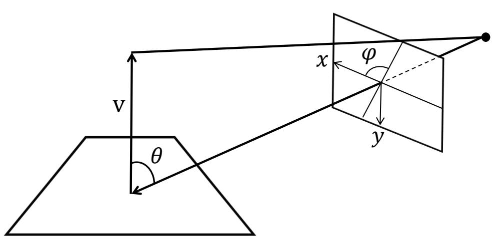
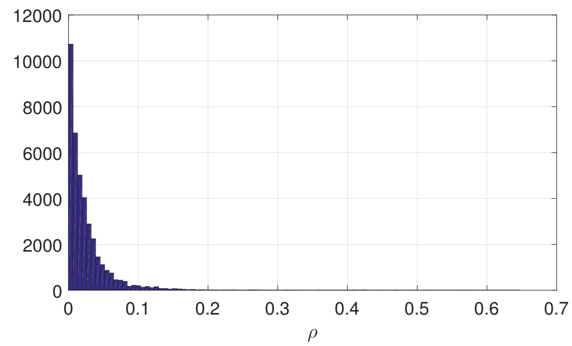


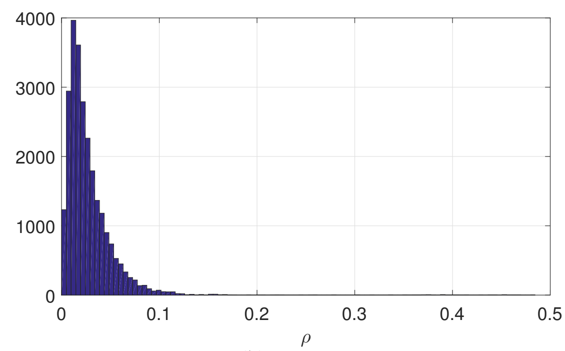
Figure 1. Illustration of azimuth and zenith angles.

2. Distribution of ρ on Real Data

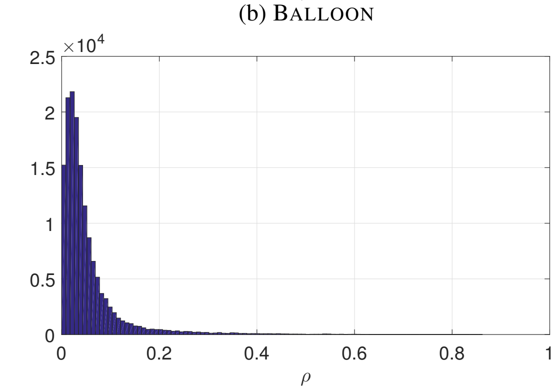
In this paper, we only studied the case for diffuse reflection. This is motivated by the observation that in practice, most points which we are able to match between different viewpoints using standard approaches (*e.g.* SIFT) do not have specular reflections. Figure 2 shows the histogram of the degree of polarization ρ for all the pairwise matched points in the three real datasets considered in the main paper. The degree of polarization can be used in practice to distinguish between specular and diffuse reflection, see *e.g.* [2]. As it is pointed out in [1], for these datasets, there are in fact both specular and diffuse reflections. However, from Figure 2, we can see that almost all of these matched points have degrees of polarization which are smaller than 0.1, indicating that they are very likely to be the diffuse-dominant points.



(a) VASE



(b) BALLOON



(c) TALLVASE

Figure 2. Histogram of the degree of polarization for the matched points in real datasets. Most of these points have degrees of polarization which are smaller than 0.1.

Methods	5-point		2-point		
	Initial	Sampson	Initial	Sampson	Optimized
R_{err}	5.97	4.59	3.95	3.90	**3.23**
t_{err}	8.18	6.76	5.45	5.05	**4.23**
t_{err}^d	0.136	0.110	0.094	0.086	**0.073**

Table 1. Results of the synthetic experiment by adding noise on image observations. R_{err} and t_{err} are the mean angular rotation and translation errors measured in degree. t_{err}^d is the mean translation error measured in Euclidean distance.

Note that while we only consider the diffuse reflection in the main paper, we believe it would be possible to extend the method to also handle the specular reflection case.

3. Evaluation with Different Simulation Setup

In the main paper, we added noise to the measurements of the phase angle and degree of polarization individually for better understanding. We have also evaluated our method by adding noise into the simulated image observations so that the degree of polarization and phase angle can be calculated from these noisy inputs. The multiplicative noise is used with a standard deviation of 2%, and all other setups are the same with those in the main paper. The results are listed in Table 1. We can see that the results are qualitatively similar to our previous synthetic experiments.

References

[1] Zhaopeng Cui, Jinwei Gu, Boxin Shi, Ping Tan, and Jan Kautz. Polarimetric multi-view stereo. In *Proc. of Computer Vision and Pattern Recognition (CVPR)*, pages 1558–1567, 2017.

[2] Achuta Kadambi, Vage Taamazyan, Boxin Shi, and Ramesh Raskar. Polarized 3D: High-quality depth sensing with polarization cues. In *Proc. of International Conference on Computer Vision (ICCV)*, 2015.