A Differential Approach to Shape from Polarization - SUPPLEMENTARY MATERIAL

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1 Synthetic data generation

In this section, we introduce some additional well-known notions for polarisation imaging to explain what affects the quality of the level-set retrieved using

\[ z_x \left( -I_x + I_+ \right) + z_y \left( I_0 - I_+ + I_- \right) = 0. \] (1)

1.0.1 Preliminaries

An important quantity that needs to be considered while dealing with polarisation images is the degree of polarisation, generally defined per pixel as

\[ \rho = \frac{I}{I_+} \] (2)

which can be differently computed depending on the particular material under observation as we show later [\textsuperscript{[1]}].

Diffuse reflection  When the material reflects light in a diffuse way, it can be shown that the degree of diffuse polarisation depends on the zenith angle \( \phi \) and the refractive index of the reflecting medium \( \mu \) (typically \( \mu = 1.6 \)) as follows

\[ \rho_d = \frac{\left( \mu - \frac{1}{\mu} \right)^2 \sin(\phi)^2}{2 + 2\mu^2 - \left( \mu + \frac{1}{\mu} \right)^2 \sin^2(\phi) + 4\cos(\phi)\sqrt{\mu^2 - \sin^2(\phi)}}. \] (3)

Specular reflection  Instead, when specular reflection comes into play, the degree of specular polarisation can be computed as follows

\[ \rho_s = \frac{2\sin^2(\phi)\cos(\phi)\sqrt{\mu^2 - \sin^2(\phi)}}{\mu^2 - \sin^2(\phi) - \mu \sin^2(\phi) + 2\sin^4(\phi)}. \] (4)
2 Measurement of level-set quality on real data

In this section we show experimentally how the quality of the level-set given by (1) depends on the degree of polarisation (2).

In Figure 1 the level-set for objects made of different materials have been retrieved. Figure 2 shows that the quality of the isocontours depends on the degree of polarisation that for the owl statue is very low due to the rough material.

Figure 1: From left to right, real data level-sets of a plastic ball, cement owl statue, ceramic cup and head of mannequin [2].

Figure 2: Real data degree of polarisation $\rho$. The scale is black is $\rho = 0$, white is $\rho > 0.25$. Note that the owl statue and face statues gets a very minimal polarisation compared to the specular cup and ball. In addition, note that $\rho$ is higher at object boundaries where the zenith angle $\phi$ is higher.

References
