Visual estimation of surface BRDF

James A. Ferwerda
Chester F. Carlson Center for Imaging Science, Rochester Institute of Technology

The bi-directional reflectance distribution function (BRDF) is a representation used in radiometry to describe the spectral and directional reflectance properties of an opaque surface. BRDF features such as the diffuse and specular reflection are associated with surface appearance properties such as color and gloss. In practice BRDF data are often approximated with light reflection models. For example the Ward model characterizes the BRDF in terms of three parameters, ρ_d, the diffuse reflectance of the surface, ρ_s, the specular reflectance of the surface, and α, the standard deviation of the surface slope. Recent advances in our understanding of material perception have benefitted greatly from the use of computer graphics methods that can render photorealistic images from BRDF models, but acquiring BRDF model parameters for real surfaces has been difficult due to the complexity and cost of the goniospectrophotometers required to measure surface BRDFs. In this project we present a method for visually estimating the Ward model parameters of real-world surfaces using a smartphone. We estimate ρ_d by scaling and linearizing the RGB values extracted from an image of the surface. We estimate ρ_s by applying the Fresnel equation. Finally, we estimate α by displaying a square wave grating on the smartphone screen, reflecting the grating in the surface under consideration, and adjusting the spatial frequency of the grating until it is just visible. An algorithm that incorporates display characteristics, human contrast sensitivity, and viewing geometry allows us to estimate α from the grating spatial frequency at threshold. We validate of the method by measuring real surfaces, simulating the surfaces using parameters estimated through the method, and comparing images of the real and simulated surfaces.