COMP70058 Computer Vision

Tutorial 6 - Photometric Stereo

Sample Answers

1.

$$R(p,q) = \rho(n \cdot s)/(|n||s|)$$
$$= \rho(ps_x + qs_y - s_z)/\sqrt{p^2 + q^2 + 1}$$

(in these examples, $|s| = 1$)

Let $K = \rho/\sqrt{p^2 + q^2 + 1}$

We have:

$$65 = K(-q)$$
$$52 = K(p)$$
$$26 = K(-1)$$

So

$K = -26$, $p = -2$, and $q = 2.5$

2.

According to the Bidirectional reflectance distribution function (BRDF) model, a surface may distribute the amount of light it receives in any outward direction. This is the most general known model for opaque surfaces. Some techniques have been developed to model (almost) general BRDFs. In practice, all of these require many light sources to obtain reliable data. These are methods in which surfaces with general BRDFs can be measured. One example is given below.

Determine the explicit BRDF prior to scanning [1]. To do this, a different surface is required that has the same or a very similar BRDF, of which the actual geometry (or at least the normal vectors for many points on the surface) is already known [2]. The lights are then individually shone upon the known surface, and the amount of reflection into the camera is measured. Using this information, a look-up table can be created that maps reflected intensities for each light source to a list of possible normal vectors. This puts constraints on the possible normal vectors the surface may have, and reduces the photometric stereo problem to an interpolation between measurements. Typical known surfaces to calibrate the look-up table with are spheres for their wide variety of surface orientations.

1. Katsushi Ikeuchi, 1981. Determining Surface Orientations of Specular Surfaces by Using the Photometric Stereo Method. In IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. PAMI-3, issue 6, pages 661-669. IEEE.
2. Aaron Hertzmann and Steven M. Seitz, 2005. Example-Based Photometric Stereo: Shape Reconstruction with General, Verying BRDFs. In IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 27, no. 8. IEEE.