

## 2IV60 – Exercise 6: Illumination and shading

1. Given a triangle after transformation, with reflection properties and a light source. Give three ways to calculate colors for the interior of the triangle and discuss pro's and cons.
2. In an application for the visualization of hard disks (SequoiaView) files are shown as cushions. These cushions are modeled as quadratic surfaces:  
$$z(x, y) = ax^2 + bxy + cy^2 + dx + ey + f,$$
where  $x$  and  $y$  are given in pixels and where  $z$  represents the height of the cushion. Furthermore, a light source is given, which is located at infinity in the direction  $L = (L_x, L_y, L_z)$  with intensity  $I$ . The surface reflects the light diffusely and has reflection coefficient  $k$ .
  - a) Calculate the normal  $N(x, y)$  on the cushion surface;
  - b) Geef een procedure om de helderheid  $I_s = I_s(x, y)$  te berekenen;
  - c) A colleague claims that the use of  $L = (0,0,1)$  reduces the number of calculations strongly. Is that correct?
3. Suppose, we want to enable users of an interactive graphics application to specify the position of a light source easily. We solve this by showing a sphere with a radius of  $r$  pixels in a separate window, projected orthogonally, centered at a pixel  $(c, c)$ . Users can indicate where they want a *highlight* (i.e., the specular reflection of the light source) to appear by clicking at a point of the sphere with the mouse.
  - a) Give a procedure to determine the normal on the surface of the sphere, given a point  $(x, y)$  indicated by the user.
  - b) Determine the corresponding position of the light source (at infinity).
4. Given two polygons  $P$  and  $Q$ , with colors  $A$  and  $B$ , and with transparency  $\alpha$  en  $\beta$ . The background color is  $C$ .
  - a) Give the colors of the two polygons after display, assuming no overlap, using a simple model for transparency.
  - b) Give the color that results when polygon  $P$  is shown on top of polygon  $Q$ , and the color that we get when  $Q$  is displayed on top of  $P$ ;
  - c) For which value(s) of  $\alpha$  en  $\beta$  does the order of display not matter for the final result?

5. Given a cylinder:  $x^2 + y^2 \leq 1$ ;  $0 \leq z \leq h$ . It is desired to make an image of the cylinder using ray-tracing. The ray is given by a point  $P$  and a vector  $V$ . Determine:
- a) The intersections of the ray with the cylinder wall;
  - b) The intersections of the ray with the upper and lower plane of the cylinder;
  - c) The interval where the ray is inside the cylinder.