

# CSCI 4229 Assignment 4: Shading

**Due: March 11.**

This assignment is intended to help you examine the range of appearance effects you can generate with OpenGL lighting and material parameters.

The object to be rendered is a model of a bunny derived from laser range scan data. The reconstructed data was downloaded from the Stanford 3D Scanning Repository (<http://graphics.stanford.edu/data/3Dscanrep/>). The files there are in .ply format. I have written a module with a routine:

```
readPlyData(char *iname, int *nvert, double **vert, double **colr,  
            int *nface, int **faces);
```

which will give you matrices containing the vertices (vert) and faces (faces), these are 1D, so you'll have to do appropriate indexing. Faces is an  $nface \times 3$  integer array, with 3 vertex indices for each triangle (face). If you prefer to write your own I/O routines, feel free to do so.

Once you have the vertex and face information you will have to compute the vertex normals. For the shading models we use, the vertex normal for a vertex  $v$  surrounded by triangles  $t_1, t_2, \dots, t_k$  is defined as:

$$n_v = \frac{n_{t_1} + n_{t_2} + \dots + n_{t_k}}{|n_{t_1} + n_{t_2} + \dots + n_{t_k}|}.$$

The model is not centered at the origin. You must translate the centroid of the data to the origin. Choose a color other than grey or white for the bunny surface. Write a display function which draws the model triangles and sets the correct normal for each vertex. Initially place the light source at  $\{0, 5, 1, 1\}$ . Explicitly set the viewer to be local (rather than the default distant viewer).

As with the previous assignment, your program should allow the user to quit by striking 'q' or 'Q'. You should provide your own reshape function which scales the model with window size, maintaining the correct aspect ratio. You should define a popup menu for the left mouse button with the entries:

- Shade Model: this is a submenu with entries
  - Flat
  - Smooth
- Light: this is a submenu with entries
  - Position
  - Diffuse
  - Specular
  - Ambient
- Material: this is a submenu with entries
  - Shininess

- Diffuse
- Specular
- Ambient
- Global Ambient

Selecting flat or smooth from “Shading Model” sets the OpenGL flat or smooth shading model. Selecting Light or Material submenu entries or “Global Ambient” should allow you to adjust the indicated shading parameter using the up/down arrow keys. For light position move the light in a circle of radius 5 in the  $X - Z$  plane at  $Y = 5$ . Selecting a new menu item, causes the arrow keys to adjust the new parameter.

The right mouse button menu should contain entries:

- Metal
- Carbon

which when selected should render the bunny with a set of parameters which make it appear to be made of metal or a very matte carbon finish respectively.

As you explore the possible combinations of material and lighting properties, recall that in the Phong model total intensity  $I$  for a surface point is the sum of the ambient, diffuse and specular intensities:  $I = I_{amb} + I_{diff} + I_{spec}$ , where:

$$\begin{aligned}
 I_{amb} &= k_{amb}L_{amb} \\
 I_{diff} &= \frac{1}{a+bd+cd^2}k_{diff}(\mathbf{l}\cdot\mathbf{n})L_{diff} \\
 I_{spec} &= \frac{1}{a+bd+cd^2}k_{spec}L_{spec}(\mathbf{r}\cdot\mathbf{v})^\alpha
 \end{aligned}$$

$L_{xxx}$  are the the lighting parameters,  $k_{xxx}$  are the material reflection coefficients,  $\alpha$  is the shininess coefficient and  $\mathbf{l}$ ,  $\mathbf{n}$ ,  $\mathbf{r}$  nd  $\mathbf{v}$  are the light, normal, ideal reflection and viewer vectors respectively.