Graphics 2 Matlab exercise classes

Exercise 4: Surface lighting

Define and display a sphere using Matlab script in **`ex_4_lighting.m`** and apply various light effects. This can be done in two ways:

- using a Matlab 'properties' interface, by calling the `inspect` function,
- using specific Matlab functions.

The list of relevant functions is given in the Appendix.

The code in **`ex_4_lighting.m`** sets the ambient light coefficient to 0.4, the diffuse light coefficient to 0.5 and the specular light coefficient to 0.0. Try the effects suggested below; for each setting rotate the sphere to see how the light changes affect the surface appearance at different locations.

1. Switch off the diffuse light.
2. Diffuse light at 0.5, ambient light switched off; now keep decreasing the diffuse light coefficient down to 0.
3. Ambient light at 0.4, diffuse coefficient at 0.4, keep increasing the specular strength up to 1.0.
4. As in (3) above, with the specular coefficient at 1.0, vary the specular exponent from 1 to 50. Why does the radius of the specular reflection decrease when the specular exponent increases?

5. As in (3) above, with the specular coefficient at 1.0 and specular exponent at 40 do the following:

   - set the position of the light source using **`lightangle(L,-10,50);`**

   - vary the position of the camera using the function `view` using spherical coordinates `azimuth` and `elevation`. Observe the changes in the amount of the specular light reflected at different camera positions.

6. Re-set the light and camera positions to

```
lightangle(L,-10,50); % Light
view(-45,35); % Camera
```

   Using the reflectance parameters as in (3) above, with the specular coefficient at 1.0, specular exponent at 40 and specular colour reflectance at 1.0, change the light colour (function **`set(L,'Color',[r,g,b])`**) to:

   - green

   - red

   - yellow

   Observe and explain the effects.

7. Change the sphere colour to yellow

```
C(:,:,1)=1.0*C(:,:,1); %R
C(:,:,1)=1.0*C(:,:,1); %G
C(:,:,1)=0*C(:,:,1); %B
```

and repeat the experiments in (6).

Appendix

Specifying light properties and light-surface interactions in Matlab

Generate surface

```
[X Y Z]= ...
S=surf(X,Y,Z);
```

Define colours

- Indexed colour
- True colour

  the size of the array is the size of data x 3

  e.g. `C=ones(size(X,1),size(X,2),3);`

Define surface properties

There are several methods

- example for a specified surface S:

```
set(S,...
      'CDataMapping','direct',...
      'CData',C,...
      'FaceLighting','flat',...
      'FaceColor','flat',...
      'FaceAlpha',1,...
      'EdgeColor', 'none',...
      'AmbientStrength',ka,...
      'DiffuseStrength',kd,...
      'SpecularStrength', ks,...
      'SpecularExponent',n,...
      'SpecularColorReflectance',sc);

surfl(X,Y,Z,[ka,kd,ks,n]);


[Nx,Ny,Nz]=surnorm(X,Y,Z);
diffuse(Nx,Ny,Nz,D);          % D – direction of the light source
specular(Nx,Ny,Nz,D,V,n);     % D – direction of the light source
                              % V – view direction
                        % max value when N is in the direction (D+V)/2
```

- for the current surface:

```
material([ka,kd,ks,n,sc]);
```

Specify the (camera) viewing parameters

(these are 'axis' properties in Matlab)

- View direction

```
view(az,el)        % Azimuth and elevation
view([x,y,z])      % Cartesian coordinates
```

- Camera position and target

```
campos([x,y,z]);
camtarget([x,y,z]);
```

- Camera up-vector

```
camup([xu,yu,zu])
```

- Camera view angle

```
camva(a);
```

Specify the light properties

```
L=light;    % New light object
```

- Position in <u>camera</u> coordinates

```
camlight(L,az,el);
```

- Position in <u>axis</u> coordinates

```
set(L,...
       'Position',[x,y,z],...
       'Style','infinite',... %'local',...
       'Color',[r,g,b]);

lightangle(L,az,el);
```

If the `Style` property is set to `local`, `Position` specifies the actual location of the light (which is then a point source that radiates from the location in all directions). If the `Style` property is set to `infinite`, `Position` specifies the direction from which the light shines in parallel rays.