159.235 Assignment 3 - A 3D Graphics Scene

This assignment covers the concepts of coordinate transformations (in homogeneous coordinates), ray tracing, illumination shading, and texture mapping. The necessary theory together with programming tips, will be discussed in the lectures.

Getting started

The Stream site provides some startup `.java` code together with some images you can use as texture maps.

- Bring up IntelliJ and create a new project - call it `Assignment3` (or whatever you like). Create a new package called `nz.ac.massey.a3`.

- Copy all the `.java` files from Stream in to the package folder in IntelliJ.

- Copy the images into the top level folder of your project

- Run `Main.java` from IntelliJ. You should see a JPanel/JFrame with a little blue square at the centre. This is the view of the graphics scene comprising a single plane surface from the point-of-view of an imaginary camera placed on the z-axis and looking down.

- Have a look at the code and read the comments and figure out what is going on. Note that the planar surface is rendered by the ray tracing method.

- Our initial graphics scene comprised just of a unit xy-plane centred on the world coordinate origin. Try changing the size, orientation, and displacement of the plane and see what happens.

- Try changing the camera position and see what happens.

Going further

The next steps are to try and render other shapes, and implement shading, colouring, and texture mapping.

- Now try and draw a sphere. You will need to complete the ray intersection computation in the `Sphere` class which is a subclass of `SurfaceGeometry`. You should see this rendered as a filled circle on your display.

- Complete the shading to include the ambient, diffuse, and specular reflection terms. You need to take into account the position of ray intersection with the surface as well as the positions of the light source and view point.

- Complete the texture mapping procedure so that a 2d image can be pasted onto any of the surfaces (planar and spherical). Do this by making another subclass of the `SurfaceColour` class.

- Try and create 6 planes and manipulate them so that they form the 6 faces of a cube. Treat this as a compound figure.

The assignment

With these tasks complete, use your project to generate a realistic 3D graphics scene comprising planar and spherical surfaces.

Requirements

To get **high marks** you should showcase the following:

- A plane surface with a texture pasted on it.

- The visible faces of a uniform colour cube correctly placed and shaded.

- A uniform colour sphere with a shiny surface (ie specular highlight)

- A sphere with a texture pasted on it (eg the beachball)

To get **full marks** you should generate a scene that adds more to the above. Marks will be awarded for initiative. Be creative!

This assignment can be completed using the ideas discussed in the lectures together with your own programming skills. You are not being asked to do your own research in advanced APIs that may be out there. **Do not use OpenGL. Do not use Java 3D. Do not use `java.awt.GradientPaint`.**

A graphical user interface is not required in this assignment. Your program should directly display the rendered scene to the screen upon running the program. An additional class `Display` is provided to do that.

This assignment will count up to 15% of your final grade.

Due date: **2021 May 30 11:55 pm**.