# CPSC 314 Assignment 3

Term: September 2007, Instructor: Wolfgang Heidrich, heidrich@cs.ubc.ca, http://www.ugrad.cs.ubc.ca/~cs314

## Due: Programming portion: Apr. 1, noon; Theory: Apr. 1 in class

**NOTE: the programming portion needs to be demoed to the TAs during your lab session between April 2 and 7!**

## Assignment 3.1: Texture Mapping (10 Points)

Consider the triangle $T = (P1, P2, P3)$, where, **in screen-space, homogeneous coordinates** $P1 = [-2, -1, 0, 1]^T$, $P2 = [2, 1, -1, 1]^T$, and $P3 = [2, 0, -2, 2]^T$. Furthermore, the $(s, t)$ texture coordinates at the vertices are defined as $(.25, .1)$, $(.8, .8)$, and $(.6, 1)$ respectively.
a) Let $T'$ be the 2D triangle that corresponds to this triangle on the screen, and let $P1'$, $P2'$, $P3'$ be its vertices. What are the screen-space positions of these vertices?

b) Compute the $(x, y)$ center point of the triangle $T'$ in screen space.

c) Compute the $s$ texture coordinate at this point, using Barycentric coordinates.

d) Compute the $s$ coordinate at the same point, using the perspective correct formula from class.

# Assignment 3.2: Graphics Demo (30 Points)

Implement a scene, animation, game, or tutorial of your choice in OpenGL. You may work alone or in pairs. In the latter case, you need only hand in one demo. If you work in pairs, the project also needs to be correspondingly more ambitious.
A list of ideas is suggested below. **Your final mark will be based in part on a short demo given to a TA in your lab session on the 28th or 29th.** You can use any of the OpenGL demo programs provided during this course as a starting point if you like, although you should document this in your README file.
If you need help regarding how to implement any particular features, do not hesitate to ask the instructor or the TAs. Be sure to develop your project in testable stages. The best demos will be glorified forever in the 314 Hall of Fame!

- **Driving Game.** Create a world with roads, or perhaps rough terrain without roads. Implement a mouse or keyboard interface for steering your virtual car around in this world. Ideas for optional features could include collision detection, night-driving mode, having the car leave tracks on the pavement or sand, providing control over the camera point-of-view (first person, third person, etc.), adding other autonomous cars in the world, etc. Be creative and add your own features.

- **Tutorial Application.** Implement a tutorial for some part of the course that you think would benefit from a demonstration or tutorial. One idea is to generate a 3D graphics visualization of the various rays that are produced during ray tracing a simple scene. Or maybe an interactive illustration of the steps in shadow algorithms such as shadow mapping or shadow volumes. One last idea is to graphically illustrate, in 3D, the various vectors involved in performing local lighting computations. As the user moves the mouse, the vectors N,R, L, V are all drawn for the given surface point.

- **Ray Tracer.** Build a simple ray tracer. Begin with simple scenes. A single reflective sphere that sits on a checkerboard terrain is a good test case. Work towards more complex scenes as time allows.

- **Fractal Terrain.** Interesting mountain-like terrains are easily generated using a recursive procedure and random numbers. Talk to the instructor or your TAs if you are interested in this.

- **Surfaces of Revolution or Swept Surfaces.** An object like a wine glass is a surface of revolution. It can be generated by rotating a curve around some axis - in the case of the wine glass this would be the vertical axis. Build an application which lets you draw a curve using the mouse, and then this curve is turned into a 3D object by rotating it around a given axis, or by sweeping some other fixed cross-sectional shape along the curve.

- **Particle System.** Use simple physics (F=ma) to animate a set of points, for example to simulate a firework.

- **Another demo of your choosing.** Create an OpenGL scene or animation that illustrates something that you have a personal interest in. Add something interesting to one of the previous assignments.

- **Research Report.** Investigate some area of interest to you in further depth. How can one achieve a certain visual effect? What kind of methods are available for accelerating ray-tracing? How do movies or games achieve certain special effects?

  Research reports should be 6-8 pages in length, and must be written by individuals (no working in pairs!). They also need to have a focus on technical aspects such as algorithms or underlying physical models for a certain phenomenon. Typically, a research report will summarize 2-3 scientific articles on a given topic. A good starting point for finding articles on graphics-related topics are the annual ACM Siggraph proceedings. You can find these in the library, reading room, or on the ACM Digital Library (which is freely accessible from UBC computers).

**Hand-in Instructions**

You do not have to hand in any printed code. If you work in pairs, only one of you needs to submit the code. **The theory portion, and the collaboration statement on the next page must still be submitted individually.** Create a README file that includes the names and login ID of the group members of your project, and any information you would like to pass on the marker. Create a folder called `assn3` under your cs314 directory and put all the source files, your makefile, and your README file there. Also include any images that are used as texture maps. Do not use further subdirectories. The assignment should be handed in with the exact command:

```
handin cs314 assn3
```

# Collaboration Policy

The theoretical part of this assignment is intended to be solved by individual students. The programming part **can** be a joined project with one partner.
If you have collaborated with other students on the solution to this assignment, this fact needs to be disclosed in the form below. In case of a collaboration on the programming part, you should also specify who did which parts of the project. Likewise, if external resources (other than the course web pages and text book) were used for solving the assignment, they need to be listed below. **Failure to disclose a collaboration or external resources constitutes an act of academic misconduct, and will be reported to the dean**.

# Declaration

I hereby declare that I have read and understood the above statement.

Name:

Student ID:

Signature and Date:

I have used the following external resources:

I have collaborated with the following individuals (explain degree of collaboration):