Coursework commentary 2017–2018

CO3355 Advanced graphics and animation

Coursework assignment 2

General remarks

There were two parts to this coursework assignment. Part A asked students to implement per-vertex and per-pixel lighting by writing appropriate GLSL shaders. In Part B, which comprised three questions, students were asked:

- To implement model deformation using a greyscale image as a heightmap.
- To develop a similar method for modifying surface normals.
- To experiment by combining the two methods.

Overall, and on a par with the coursework assignment 1, the quality of submissions varied considerably.

There were a number of excellent submissions that were based on research on online resources, competent coding and experimentation. These submissions included a step-by-step explanation of the design and development process, exposing technical obstacles faced and ways that these were tackled. Each step was accompanied by detailed screenshots and critical evaluation of their work.

On the other hand, there were also students who faced considerable difficulties. These were mainly due to the complex nature of the mathematics involved in 3D graphics, variations across different OpenGL ES versions, but also because of the somewhat cumbersome nature of GLSL development and especially debugging. The latter is an inherent drawback of languages that use the GPU for calculations, as it is very difficult to communicate variables back to the CPU in order to debug the code.

Due to these factors, coursework assignments for this module can prove quite demanding. However, they can also foster creativity and provide students with very effective skills applied to real world scenarios and widespread technologies. For instance, WebGL, a very popular HTML5/JavaScript API, is based on the same GLSL specification as the one examined in this course. Moreover, the examiners do take these difficulties into account and do not look for great complexity or efficiency of code. Instead they look for well-motivated design decisions that address what has been asked for in the assignment specification, rewarding students for their journey, should it be well-reasoned and properly documented.

To that end, reporting is really important for a good submission. Unfortunately, this year there were many cases where the accompanying report was not of high quality. Many reports lacked basic structure, while others were too short, failing to give details on the implementation decisions and to provide a critical evaluation of the work carried out. Concise reporting is a very important aspect of the assignment evaluation and should be treated with attention.

Comments on specific questions

Part A

The first part of the coursework assignment examined per-vertex and per-pixel shading, asking students to implement corresponding GLSL shaders and incorporate them into a Processing program. The shaders should then also implement the Phong illumination model, by including specular, diffuse and ambient light components.

Generally, a good development strategy was to implement and test the components of the model individually and progressively incorporate them to the code, making it less prone to bugs.

Most students answered well, successfully implementing the two shading methods, which essentially correspond to Gouraud and Phong shading respectively. Successful attempts highlighted the differences between the two models. An effective way to make the differences more prominent was to experiment with the resolution of the generated object. Moreover, some students modelled – and exposed to the user via the UI – more surface properties, such as a shininess exponent that controls the surface smoothness and affects specular reflection.

Part B

Question 1

This question asked students to parse a raster image, convert it to grayscale and then use it as a heightmap in order to displace object vertices. Students were required to demonstrate the results of using two different images of their choice and incorporating a point light.

The first step was to first implement grayscale conversion. This could be done in Processing and simply averaging the three colour channels would be sufficient. However, some chose to employ slightly more sophisticated methods and do it in the vertex shader.

The second step (vertex displacement along the normal) was a typical task for the vertex shader. A new vertex position (P_1) could be calculated from the original position (P_0), using the displacement magnitude (df), and the normal (N), using the formula: $P_1=P_0+N*df$. The new position should be calculated before applying the Model View transformation.

While the vast majority of students were successful in loading an external raster image and converting it to greyscale, some had issues with the second step. From the students that implemented the latter though, many also incorporated a user factor that adjusted the displacement scale, while others experimented with multiple object resolutions. Both of these choices greatly helped to demonstrate the effects of the method.

Question 2

Question 2 required students to use the RGB values of an image in order to calculate and modify surface normals.

Many found this question quite challenging. The key here was to identify the need for a new coordinate space (*tangent space*) so that the same normal map could be used, regardless of the orientation. Accurate calculation of the tangent space coordinates can be difficult, but carrying it out in an approximate fashion was sufficient. The next step was to generate an RGB image so that the results of this exercise were similar to the ones achieved with displacement mapping in Question 1. A good answer here would also include a comparison of the two techniques in terms of difficulty of implementation, complexity of calculations and visual outcome.

Question 3

The final question asked students to try to combine displacement and normal mapping and to experiment with different properties of the effects.

This question was only answered by approximately half the students. However, those who did, took advantage of the opportunity and improvised with the two techniques, mainly by combining different maps and adjusting lighting settings. The result was a number of very interesting and creative effects.