Computer Science 715

Assignment #1 2002

Colour + Illumination, Shading & Texture Mapping

Due: 11.00am Monday 5th August.

Questions [Indicated marks are out of a total of 30.]

(1) Sketch a picture of the CIE chromaticity diagram, showing clearly

(a) where "pure hues" (i.e. the colours of the rainbow) are located

(b) the range of colours that can *not* be obtained by mixing white and a pure hue

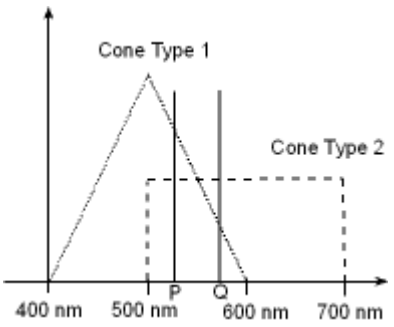
(c) how to calculate the dominant wavelength of a typical non-spectral colour

(d) the maximum range of colours that can be produced on a colour monitor using 3 phosphors. Assume that you can get phosphors to produce any colour you want (not realistic).

Please give explanations where necessary.

[4 marks]

(2) An alien spacecraft crash lands on the Earth. The sole inhabitant of the craft is vaguely humanoid in appearance, and is quickly chopped into little pieces by the scientific establishment. The scientist who acquires the left eyeball discovers that its retina contains two different sorts of cones. The spectral absorption characteristics of the two cones are shown in the figure to the right.



(a) Assuming that the alien's colour sight follows the same general scientific rules as a human's, determine the expected colour matching functions for the alien, using primaries of 525 nm (colour *P*) and 575 nm (colour *Q*). Show all your working and derivations, starting from the assumption that the alien's perception of the colour of a pure sinusoidal electromagnetic stimulus of frequency λ is quantifiable by the 2-tuple $(f_1(\lambda), f_2(\lambda))$. Also assume that in the image above the maximum absorption of cone type 1 is exactly twice the absorption of cone type 2. [7 marks]

(b) Draw the colour matching functions you obtained in part (a) of this question. [1 mark]

(c) Explain what the negative values on the colour matching functions mean in the context of a colour matching experiment. [1 mark]

(d) Suggest how to avoid having negative valued colour matching functions for the alien by a different choice of primaries. Why is this unachievable with human colour sight? [2 marks]

(3) Use the *OpenGLShadingDemo* program (provided on the 715 'Assignment' web page) to answer the following questions.

(a) Why does the colour of the ground plane appear to change when switching between "flat" and "shading"? [1 mark]

(b) With shading turned on, the cone appears to need a much higher tesselation count than the cylinder in order to appear smooth. Why? [Hint: The cone is a quadric surface, which is converted to a mesh of quadrilaterals, with normals defined at the vertices. All that code is correct – there is nothing wrong with OpenGL's implementation of that. However, think carefully about how OpenGL will render the quadrilaterals!]

[2 marks]

(c) The number of polygons required to represent the sphere realistically (i.e. so that artifacts from the polygonisation are not very obvious) varies with shininess. Determine approximately how many polygons are required for a reasonably artifact free rendering of:

- a perfectly diffuse sphere
- a sphere with specular colour (0.5, 0.5, 0.5) and shininess of 10
- a sphere with specular colour (0.5, 0.5, 0.5) and shininess of 50.

Obviously, there is no "correct" answer – different people have different tolerances to defects. Just do the best you can; don't use "zoom", and try to be consistent in your tolerance of defects. To understand the tesselation algorithm, use a small tesselation level (e.g. 4) and flat shading.

[3 marks]

(4) Add simple projected shadows, so that the four scene objects cast suitable shadows on the ground plane. You are not expected to have the four scene objects casting shadows on each other. Nor are you expected to deal with light sources that are off to the side of the scene. [Why is that a problem?]

[4 marks]

(5) Do something else cool with the OpenGLShadingDemo program using **texture mapping**. By "cool" I mean "having academic merit *and* directly concerned with graphics/image rendering". Describe exactly what you have done, and either include images in your hand-in document, or give instructions on how to observe your coolness using the handed-in code. If at all possible, modify only the *DemoScene.java* file – if you need to create additional classes, it should be possible to include them as private classes in that file. [This is just to simplify the handing-in and marking process.]

[5 marks]

Handing In

Hand in is electronic, via the usual drop-box mechanism. The main answer sheet should be either a pure text document (*.txt), an html document (*.html) or a Word document (*.doc). You will also need to hand in your revised version of *DemoScene.java* and the corresponding *DemoScene.class*. Do not include any additional source or class files unless you found it necessary to modify the main *OpenGLShadingDemo.java* file or to create extra files.

Bon Appetit
