Animação e Visualização Tridimensional

Mestrado em Engenharia Informática e de Computadores
Alameda

2º mini-test
25th November, 2015

The mini-test has a maximum duration of 45 minutes. Answer with black or blue pen to the following questions and **justify in detail** all the answers. If necessary you can use the back of the respective sheet to complete the answer. Calculators, cell phones or other mobile devices are not allowed. Identify all the sheets of your mini-test.

Good luck!

1. Consider the following OpenGL 3.3 code sample.

```
…………

glGenTextures(3, TextureArray);
LoadTexture(TextureArray[1], "marble.bmp");
LoadTexture(TextureArray[0], "wood.bmp");
LoadTexture(TextureArray[2], "steel.bmp");

glActiveTexture(GL_TEXTURE0);
glBindTexture(GL_TEXTURE_2D, TextureArray[1]);
glActiveTexture(GL_TEXTURE1);
glBindTexture(GL_TEXTURE_2D, TextureArray[0]);
glActiveTexture(GL_TEXTURE2);
glBindTexture(GL_TEXTURE_2D, TextureArray[1]);

tex_loc = glGetUniformLocation(shader.getProgramIndex(), "texmap");
……………
void render_scene() {
      ……
      glUniform1i(tex_loc, 0);
      drawObject1();
      glUniform1i(tex_loc, 2);
      drawObject2();
      …………
}
```

   a) **[1.0v]** How should be declared the GLSL variable "texmap"?

   uniform sampler2D

   b) **[1.0v]** What texture image will be used by Texture Unit 1? Justify.

   Wood.bmp   + justificação

   c) **[2.0v]** What texels will be used to shade both Object1 and Object2. Why?

Both with marble.bmp + justificação

2. You want to map a 512x512 texture image into a rectangle. And you specified a texture object that in terms of filtering is defined by these two calls:

Aluno: _____   _____

```
glTexParameteri(GL_TEXTURE_2D,GL_TEXTURE_MIN_FILTER,GL_NEAREST_MIPMAP_NEAREST);
glTexParameteri(GL_TEXTURE_2D,GL_TEXTURE_MAG_FILTER,GL_LINEAR);
```

a) **[1.5v]** In what situation, the filter of the second command will be used? Is it a point or an area sampling technique? Why?
Magnification. It is area sampling since the fragment colour results from an average of 2x2 texels.

b) Consider that a LookAt() call made the rectangle to be textured with the filter, specified in the first command, by using the level parameter (λ) equal to 5.

   i. **[1.0v]** Indicate the name of the filtering technique and in what situation is it used?
   mipmapping to be used in minification situations.

   ii. **[2.0v]** Calculate, approximately, the size of the projected rectangle in the screen.
   512x512 (nível 0), 256x256 (nível 1); 128x128 (nível 2); 64x64 (nível 3); 32x32 (nível 4); 16x16 (nível 5);
   The size should be approximately 16x16

c) **[2.0v]** The alpha channel values of the texels range between 0 and 1. Consider that the textured rectangle will be drawn in the screen, in last place, by specifying these two commands:
```
glEnable(GL_BLEND);
glBlendFunc(GL_SRC_ALPHA, GL_ONE_MINUS_SRC_ALPHA);
```
What will be the appearance of the textured rectangle.

Translucent object where the alpha channel represents its opacity.
When alpha=0, invisible fragment, so only the background pixel will be seen,
When alpha = 1, opaque fragment; the pixel will contain the color of the fragment,
When alpha=]0, 1[, the final pixel color will contain a blending of both fragment colors and pixel color

3. **[2.5v]**In your laboratory exercises you implemented the fog effect. Indicate what shader you have programmed to accomplish such effect. Indicate also what GLSL built-in function was used to blend colours as well as describe its use.
Fragment shader.
Function: mix (fog_color, frag_color, frog_amount). This function interpolates the final color between fog color and fragment color and using a blending factor based on a linear or exponential function fog density

Aluno: _____   _____

4. **[2.5v]**. Assume you have written an OpenGL display callback that only draws one cube object in the screen. Explain how could you get the effect shown below by describing in detail the mechanism used and their associated OpenGL functions.
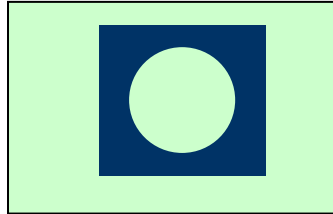
Utilizava o teste de stencil para desenhar o rectângulo, tendo o cuidado de ter preenchido o stencil buffer com uma máscara contendo uma circunferência. Este teste permite aceitar ou rejeitar um fragmento baseado num valor de referência, no conteúdo de um stencil e numa função de teste: void glStencilFunc (GLenum func, GLint ref, GLuint mask); Este teste utiliza-se tipicamente na utilização de uma máscara (conteúdo do stencil) para condicionar o desenho de uma cena. O conteúdo do estêncil é previamente definido através de glStencilOp() (os alunos devem explicitar convenientmente como usam os argumentos desta função). Poder-se-ia usar por exemplo o seguinte código:

```
//limpar o stencil com zero
glClearStencil(0);
glClear(GL_STENCIL_BUFFER_BIT);
glEnable(GL_STENCIL_TEST);
// Escrever 1 no stencil buffer com a forma da esfera
glStencilFunc(GL_NEVER,0x1,0x1); //a esfera nunca era desenhada no ecrã
glStencilOp(GL_REPLACE,GL_REPLACE,GL_REPLACE);
draw_sphere ();//preenchido o conteúdo do stencil

// Desenhar apenas onde o stencil buffer esta a 0
glStencilFunc(GL_NEQUAL,0x1,0x1);
glStencilOp(GL_KEEP,GL_KEEP,GL_KEEP);
draw_cube()
```

5. Billboarding is a very useful technique that allows significant improvement in the representation of complex objects without compromising the efficiency**.**
    a) **[1.0v]** Identify the billboarding methods studied in the Course according to their alignment with the camera.
        Camera position alignment and Viewing direction alignment.

    b) **[1.0v]** What is cylindrical billboarding?

Aluno: _____   _____

Cylindrical billboarding is a technique that constrains the rotation of the billboard to a single axis. Usually, the Y axis is selected, since it provides very natural results with commonly used walking navigation mode, but can broken the illusion of realism if the camera flies over the scene.

c) **[2.5v]** Billboarding is used by particle systems. Identify the main characteristics that a particle should own in order to implement, for instance, the fireworks demo described in a class and how are they used.

Position, velocity, acceleration, size, shape, color, **lifespan, fade**

Position, velocity and acceleration define the particle movement according to a Physics law by using a numerical method like Euler or Runge-Kutta. The Lifespan is decremented, in each frame, by the Fade parameter which can be used, like in the fireworks, to change the particle color alpha channel until it vanishes (simulate the death of a particle).