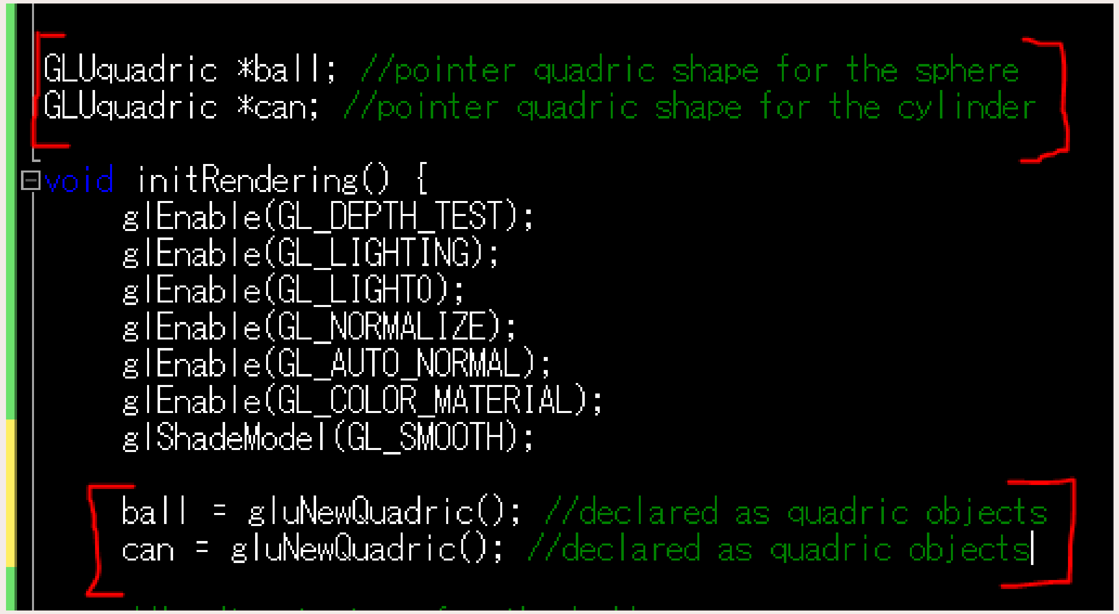
Quadric Shapes and Multi-Texturing

Mark Daniel Dacer

Quadric creation

- To creates quadric shapes with GLU, just begin with the creation of a quadric object with gluNewQuadric :
- gluNewQuadric()



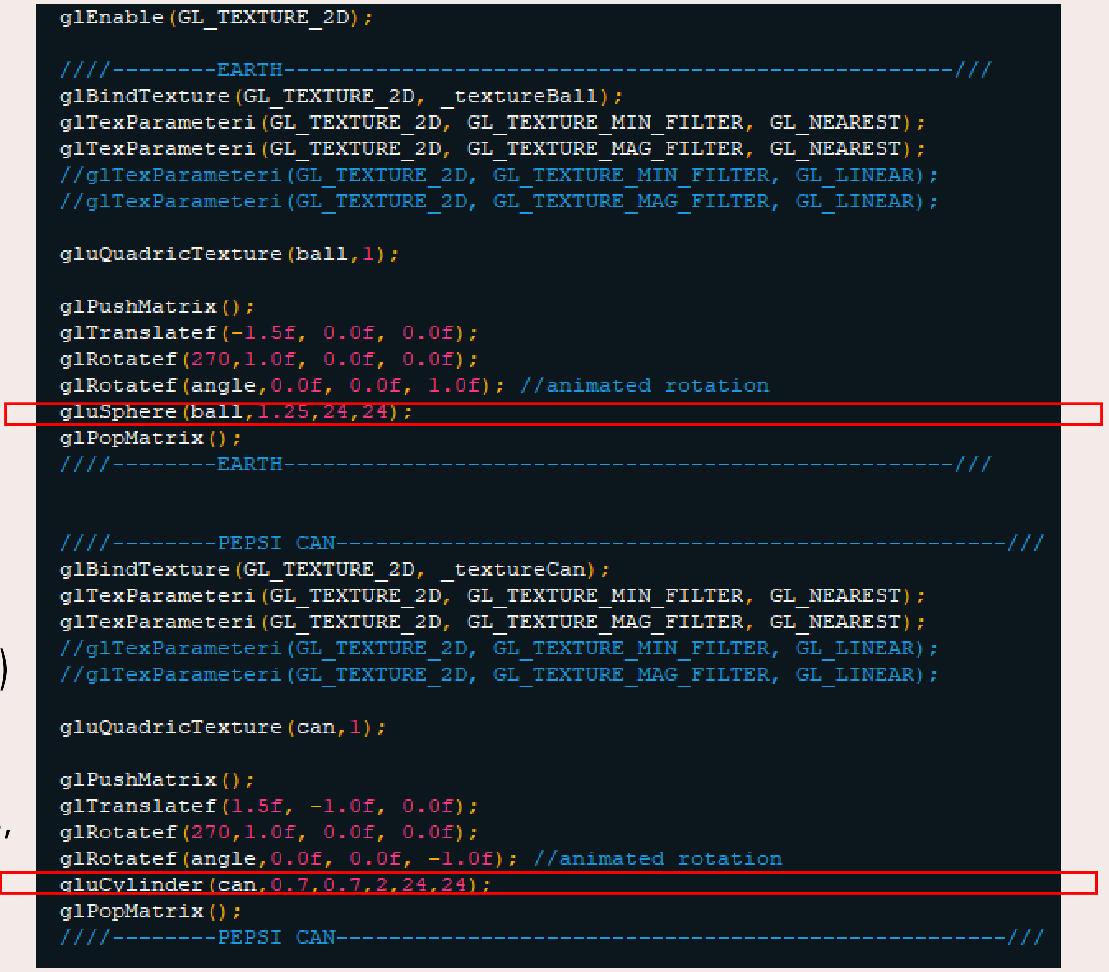
```
GLUquadric *ball; //pointer quadric shape for the sphere
GLUquadric *can; //pointer quadric shape for the cylinder

void initRendering() {
    glEnable(GL_DEPTH_TEST);
    glEnable(GL_LIGHTING);
    glEnable(GL_LIGHT0);
    glEnable(GL_NORMALIZE);
    glEnable(GL_AUTO_NORMAL);
    glEnable(GL_COLOR_MATERIAL);
    glShadeModel(GL_SMOOTH);

    ball = gluNewQuadric(); //declared as quadric objects
    can = gluNewQuadric(); //declared as quadric objects
```

Quadric rendering properties

- We can defines few rendering properties. If you don't defines these properties, the default value will be used.
  - gluQuadricTexture(quadric, value)   //Default: false
  - gluQuadricDrawStyle(quadric, value)   //Default: GLU_FILL
    - https://learn.microsoft.com/en-us/windows/win32/opengl/gluquadricdrawstyle
  - gluQuadricNormals(quadric, value)   //Default: GLU_SMOOTH
    - https://registry.khronos.org/OpenGL-Refpages/gl2.1/xhtml/gluQuadricNormals.xml
  - gluQuadricOrientation(quadric, value)   //Default: GLU_OUTSIDE
    - https://learn.microsoft.com/en-us/windows/win32/opengl/gluquadricorientation

Rendering quadric shape

- Now we have creates and defines all the properties that we need. We can draw all quadric shapes that we would with the quadric object.
- To draw a sphere :
  - glu.gluSphere(quadric, radius, slices, rings)
- To draw a cylinder (or a cone if a radius is equal to 0) :
  - glu.gluCylinder(quadric, bottomRadius, topRadius, height, slices, rings)
- To draw a CD (or a disk if internalRadius is equal to 0) :
  - glu.gluDisk(quadric, internalRadius, externalRadius, slices, rings)
- To draw a partial CD (or a piece of a disk) :
  - glu.gluPartialDisk(quadric, internalRadius, externalRadius, slices, rings, startAngle, angle)



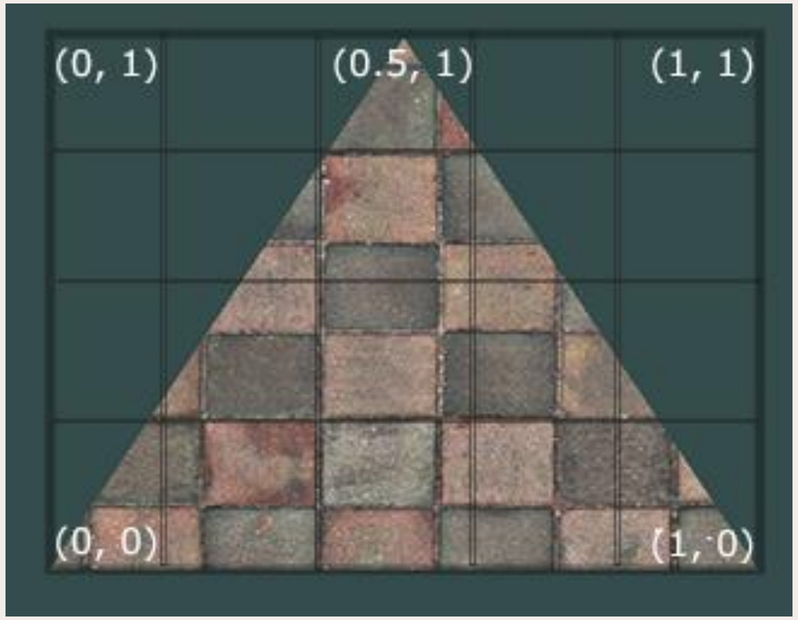
```
glEnable(GL_TEXTURE_2D);

////--------EARTH--------------------------------------------------///
glBindTexture(GL_TEXTURE_2D, _textureBall);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);

gluQuadricTexture(ball,1);

glPushMatrix();
glTranslatef(-1.5f, 0.0f, 0.0f);
glRotatef(270,1.0f, 0.0f, 0.0f);
glRotatef(angle,0.0f, 0.0f, 1.0f); //animated rotation
gluSphere(ball,1.25,24,24);
glPopMatrix();
////--------EARTH--------------------------------------------------///


////--------PEPSI CAN----------------------------------------------///
glBindTexture(GL_TEXTURE_2D, _textureCan);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);

gluQuadricTexture(can,1);

glPushMatrix();
glTranslatef(1.5f, -1.0f, 0.0f);
glRotatef(270,1.0f, 0.0f, 0.0f);
glRotatef(angle,0.0f, 0.0f, -1.0f); //animated rotation
gluCylinder(can,0.7,0.7,2,24,24);
glPopMatrix();
////--------PEPSI CAN----------------------------------------------///
```

Multi-Texturing

Textures

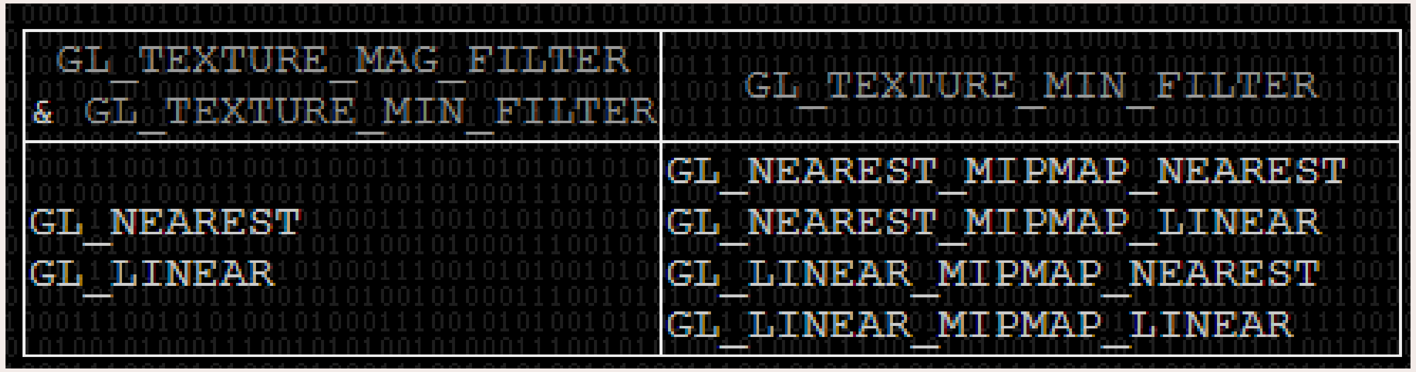
- What artists and programmers generally prefer is to use a texture. A texture is a 2D image (even 1D and 3D textures exist) used to add detail to an object; think of a texture as a piece of paper with a nice brick image (for example) on it neatly folded over your 3D house so it looks like your house has a stone exterior. Because we can insert a lot of detail in a single image, we can give the illusion the object is extremely detailed without having to specify extra vertices.

- Texture coordinates range from 0 to 1 in the x and y axis (remember that we use 2D texture images). Retrieving the texture color using texture coordinates is called sampling. Texture coordinates start at (0,0) for the lower left corner of a texture image to (1,1) for the upper right corner of a texture image. The following image shows how we map texture coordinates to the triangle:



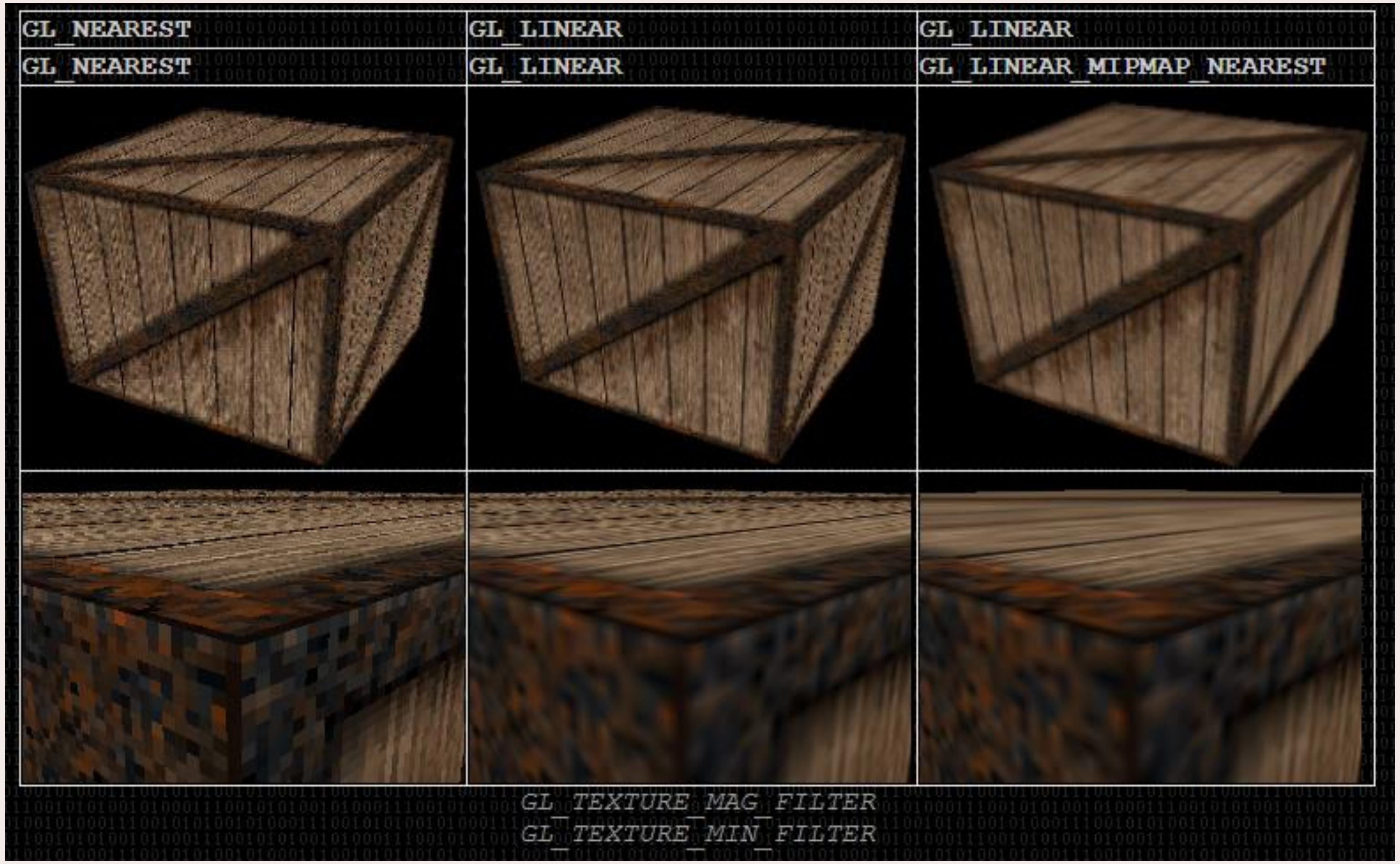
Texture Filtering

- Filters control how the texture is enlarged and shrinked. They are defined with :
- gl.glTexParameteri(target, property, value)
- target is GL_TEXTURE_2D
- property can be GL_TEXTURE_MAG_FILTER (texture magnified, enlarged) or GL_TEXTURE_MIN_FILTER (texture minimized, shrinked).
- value can be one of those constants :



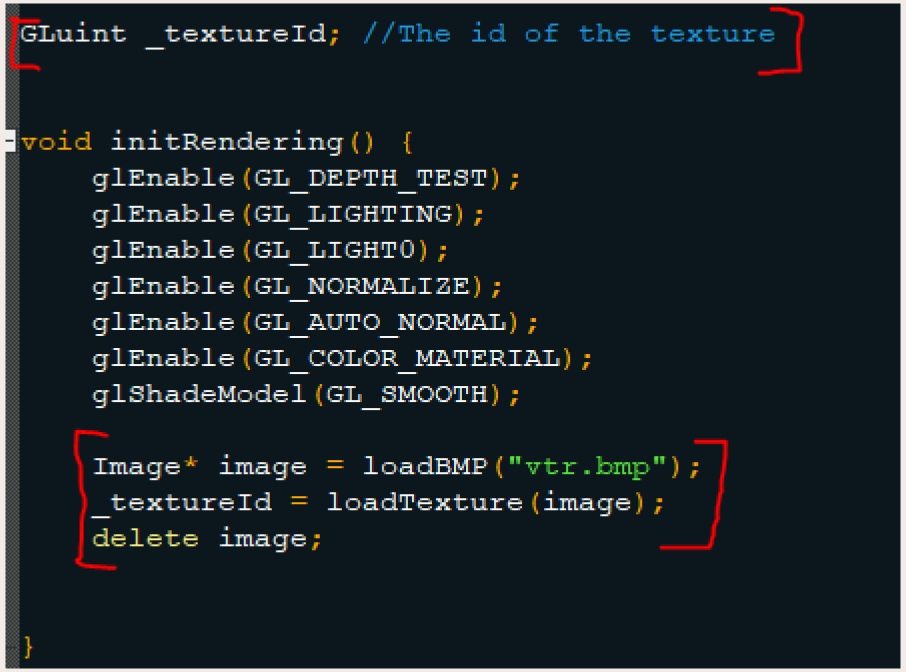
GL_TEXTURE_MAG_FILTER & GL_TEXTURE_MIN_FILTER	GL_TEXTURE_MIN_FILTER
GL_NEAREST GL_LINEAR	GL_NEAREST_MIPMAP_NEAREST GL_NEAREST_MIPMAP_LINEAR GL_LINEAR_MIPMAP_NEAREST GL_LINEAR_MIPMAP_LINEAR

- Here is the result for 3 different magnification/minification filter associations :



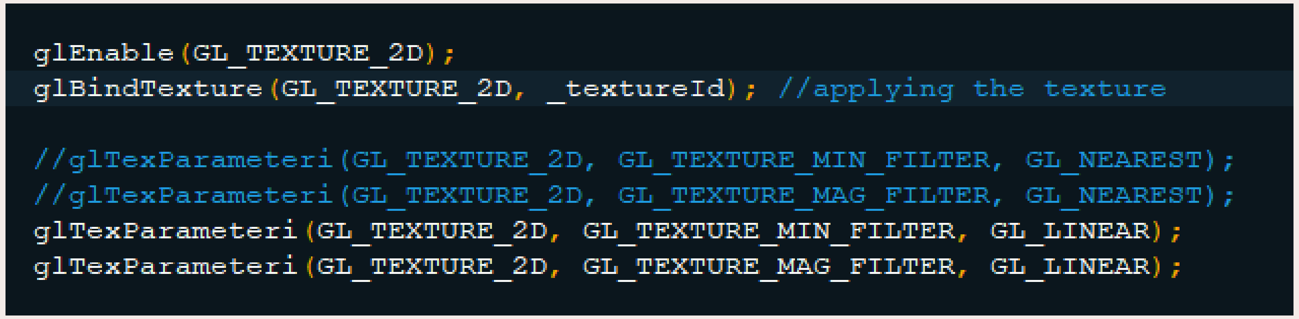
Applying texture to a primitive

1. Declare the texture id and load the image file



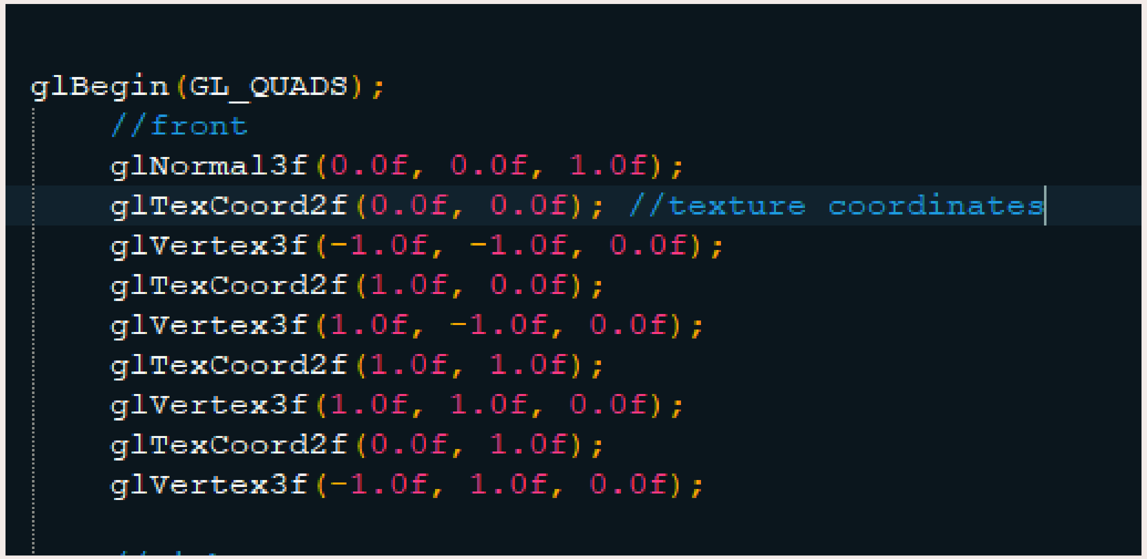
```
GLuint _textureId; //The id of the texture


void initRendering() {
    glEnable(GL_DEPTH_TEST);
    glEnable(GL_LIGHTING);
    glEnable(GL_LIGHT0);
    glEnable(GL_NORMALIZE);
    glEnable(GL_AUTO_NORMAL);
    glEnable(GL_COLOR_MATERIAL);
    glShadeModel(GL_SMOOTH);

    Image* image = loadBMP("vtr.bmp");
    _textureId = loadTexture(image);
    delete image;


}
```

2. Enable 2D textures, bind the texture and apply texture filtering



```
glEnable(GL_TEXTURE_2D);
glBindTexture(GL_TEXTURE_2D, _textureId); //applying the texture

//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);
```

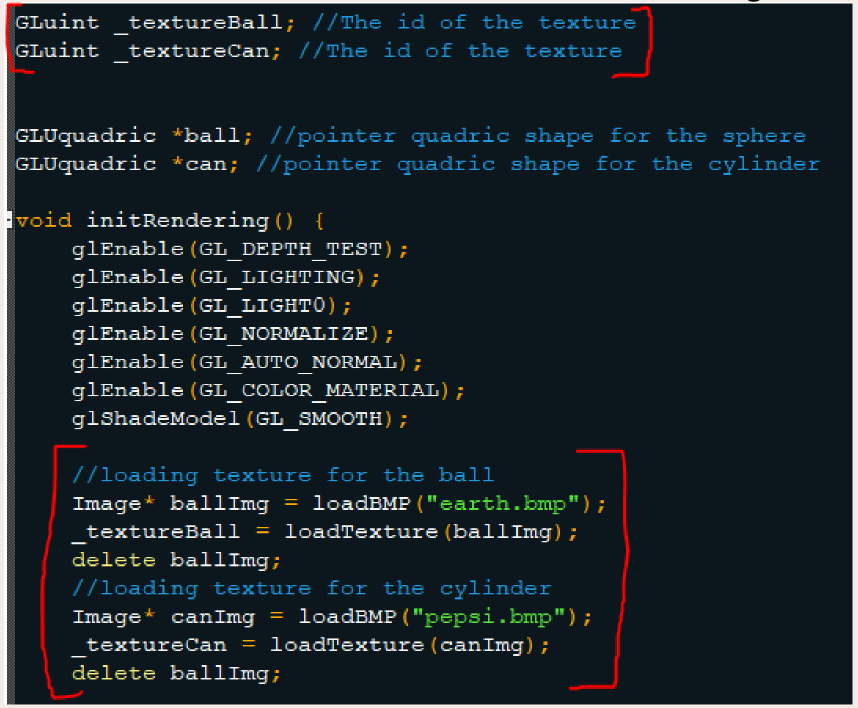
3. Apply Each texture coordinate to each vertex



```
glBegin(GL_QUADS);
    //front
    glNormal3f(0.0f, 0.0f, 1.0f);
    glTexCoord2f(0.0f, 0.0f); //texture coordinates
    glVertex3f(-1.0f, -1.0f, 0.0f);
    glTexCoord2f(1.0f, 0.0f);
    glVertex3f(1.0f, -1.0f, 0.0f);
    glTexCoord2f(1.0f, 1.0f);
    glVertex3f(1.0f, 1.0f, 0.0f);
    glTexCoord2f(0.0f, 1.0f);
    glVertex3f(-1.0f, 1.0f, 0.0f);
```

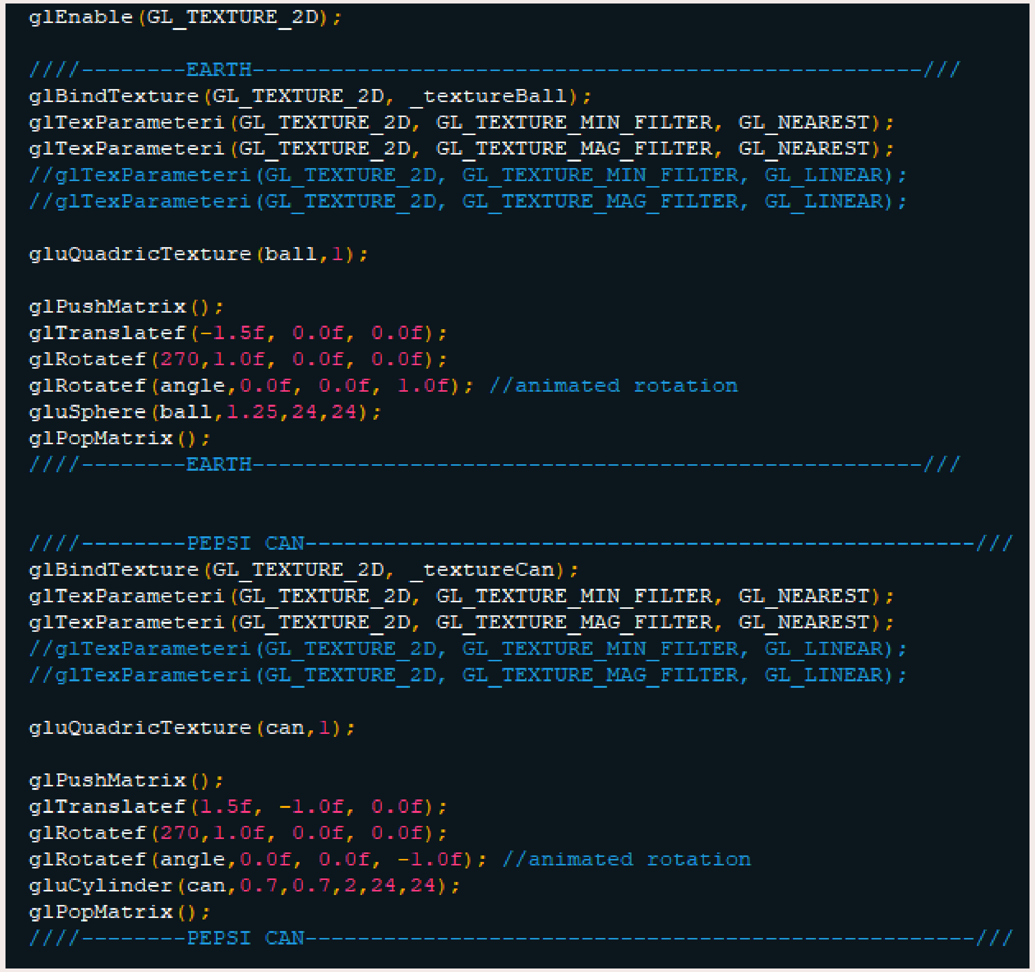
Applying texture to Quadric Shapes

1. Declare the texture id and load the image file



```
GLuint _textureBall; //The id of the texture
GLuint _textureCan; //The id of the texture


GLUquadric *ball; //pointer quadric shape for the sphere
GLUquadric *can; //pointer quadric shape for the cylinder

void initRendering() {
    glEnable(GL_DEPTH_TEST);
    glEnable(GL_LIGHTING);
    glEnable(GL_LIGHT0);
    glEnable(GL_NORMALIZE);
    glEnable(GL_AUTO_NORMAL);
    glEnable(GL_COLOR_MATERIAL);
    glShadeModel(GL_SMOOTH);

    //loading texture for the ball
    Image* ballImg = loadBMP("earth.bmp");
    _textureBall = loadTexture(ballImg);
    delete ballImg;
    //loading texture for the cylinder
    Image* canImg = loadBMP("pepsi.bmp");
    _textureCan = loadTexture(canImg);
    delete ballImg;
```

1. Apply the textures to each quadric shapes



```
glEnable(GL_TEXTURE_2D);

////--------EARTH---------------------------------------------------///
glBindTexture(GL_TEXTURE_2D, _textureBall);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);

gluQuadricTexture(ball,1);

glPushMatrix();
glTranslatef(-1.5f, 0.0f, 0.0f);
glRotatef(270,1.0f, 0.0f, 0.0f);
glRotatef(angle,0.0f, 0.0f, 1.0f); //animated rotation
gluSphere(ball,1.25,24,24);
glPopMatrix();
////--------EARTH---------------------------------------------------///


////--------PEPSI CAN-----------------------------------------------///
glBindTexture(GL_TEXTURE_2D, _textureCan);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_NEAREST);
glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_NEAREST);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MIN_FILTER, GL_LINEAR);
//glTexParameteri(GL_TEXTURE_2D, GL_TEXTURE_MAG_FILTER, GL_LINEAR);

gluQuadricTexture(can,1);

glPushMatrix();
glTranslatef(1.5f, -1.0f, 0.0f);
glRotatef(270,1.0f, 0.0f, 0.0f);
glRotatef(angle,0.0f, 0.0f, -1.0f); //animated rotation
gluCylinder(can,0.7,0.7,2,24,24);
glPopMatrix();
////--------PEPSI CAN-----------------------------------------------///
```

More Learning Links

- Textures - https://learnopengl.com/Getting-started/Textures
- Quadratic Shapes - http://jerome.jouvie.free.fr/opengl-tutorials/Tutorial7.php