CSCI 420 Computer Graphics

Helper slides, hw1 (height field)

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Understanding the Height Field

Pixel \((i,j)\)  

Vertex \((i, \text{height}, -j)\)

\[
\text{height} = \text{scale} \times \text{heightmapImage->getPixel}(i, j, 0);
\]
Solid, wireframe, point mode
FIRST, render a single triangle

• Do not attempt to render a heightfield until this works! 😊

• Please read the assignment description (in detail)

• MUST use the OpenGL core profile
  Do not use glBegin(), glEnd(), glVertex3f, etc.
Important first steps

• There must be `glutSwapBuffers()` at the end of `displayFunc()`

• There must be `glutPostRedisplay()` at the end of `idleFunc()`
Understanding modelview and projection matrices

• 4x4 matrices
• You compute them using the OpenGLMatrix class
• You send them to the shader using 
  glUniformMatrix4fv

• There are two OpenGLMatrix modes: ModelView and Projection
• Use OpenGLMatrix::SetMatrixMode to set the mode
Computing the projection matrix

- Compute in reshape()
- Change the mode to Projection
- Clear the matrix to identity (OpenGLMatrix::LoadIdentity)
- Then, call OpenGLMatrix::Perspective
- Good habit to then set the mode back to ModelView
Uploading the projection matrix to GPU

Inside displayFunc():

float p[16];
openGLMatrix->SetMatrixMode(OpenGLMatrix::Projection);
openGLMatrix->GetMatrix(p);

• Then, upload the array p to the GPU:
  See the "Setting up uniform variables" slides in the "04-Shaders" lecture.
Computing the modelview matrix

• Compute in displayFunc()
• Change the mode to ModelView
  openGLMatrix->SetMatrixMode(OpenGLMatrix::ModelView);
• Clear the matrix to identity (OpenGLMatrix::LoadIdentity)
• Then, call OpenGLMatrix::LookAt()
• Then, call OpenGLMatrix::Translate,Rotate,Scale
• Then
  float m[16];
  openGLMatrix->GetMatrix(m);
• Then, upload the array m to the GPU
Initialization

• Init and bind the pipeline program:

```cpp
pipelineProgram->Init("../openGLHelper-starterCode");
pipelineProgram->Bind();
```

• Generate the VBO and VAO, and properly upload them to the GPU

See the "Vertex Array Object" slides ("04-Shaders" lecture), and the "Vertex Buffer Object" slides ("03-Interaction" lecture).
Write the vertex and fragment shaders

• See “04-Shaders”:
  “Basic Vertex Shader in GLSL” and
  “Basic Fragment Shader”
Heightfield VBOs and VAOs

• 1 VBO + 1 VAO for solid mode
  1 VBO + 1 VAO for wireframe mode
  1 VBO + 1 VAO for point mode

• VBO contains positions and colors

• Others designs are OK too (separate VBOs for positions and colors)
Gotchas to avoid

• First, initialize OpenGL
• VAO must be initialized AFTER the pipeline program has been initialized and bound
• VAO must be initialized AFTER setting up VBO
• The order of setting up the VBO and the pipeline program does not matter

• Data sent to VBO must be contiguous.

```c
float* vertices[36];
vertices[0] = new float[3];
vertices[1] = new float[3];
...
```
Rendering (in displayFunc)

- Setup modelview and projection matrices (as shown in the previous slides in this presentation)

- Bind the VAO

- Render using `glDrawArrays()`

- See "Use the VAO" slide in "04-Shaders"