CSE 167 Discussion #4

Fiat Lux (Let there be light)

Materials/Lights

Materials

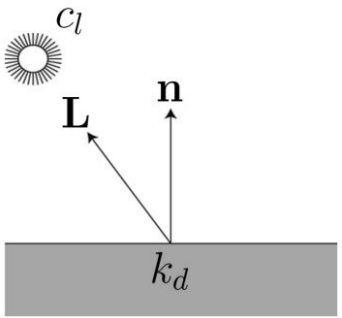
- Ambient
  - k_a
- Diffuse
  - k_d
- Specular
  - k_s
- Shininess
  - α

Lights

- Ambient
  - L_a
- Diffuse
  - L_d
- Specular
  - L_s

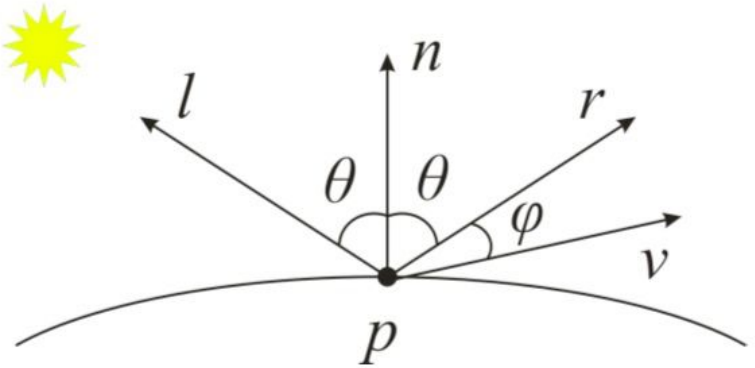
Light Calculations

- a * b
  - Component-wise multiplication
    - <a.x, a.y, a.z> * <b.x, b.y, b.z> = <a.x*b.x, a.y*b.y, a.z*b.z>
- n ˙ l
  - Dot product between surface normal and light vector
  - Light vector points from the vertex toward the light source



Light Calculations

- r ˙ v
  - Dot product between reflection vector and view vector
  - Reflection vector can be calculated using the GLSL **reflect()** function
  - View vector is camera's **e** minus vertex position



Directional Light

- Direction
- Ambient
- Diffuse
- Specular

$$\sum_{n=0}^{directional\_lights-1} [k_a L_a + k_d L_d * max(0, (\widehat{n} \cdot \widehat{l})) + k_s L_s * max(0, (\widehat{r} \cdot \widehat{v}))^{\alpha}]$$

Point Light

- Position
- Ambient
- Diffuse
- Specular

$$\sum_{n=0}^{point\_lights-1} [k_a L_a + \frac{1}{cd^2}(k_d L_d * max(0, (\widehat{n} \cdot \widehat{l})) + k_s L_s * max(0, (\widehat{r} \cdot \widehat{v}))^{\alpha})]$$

Spotlight

- Position
- Spot direction
- Spot cutoff
- Spot exponent
- Ambient
- Diffuse
- Specular

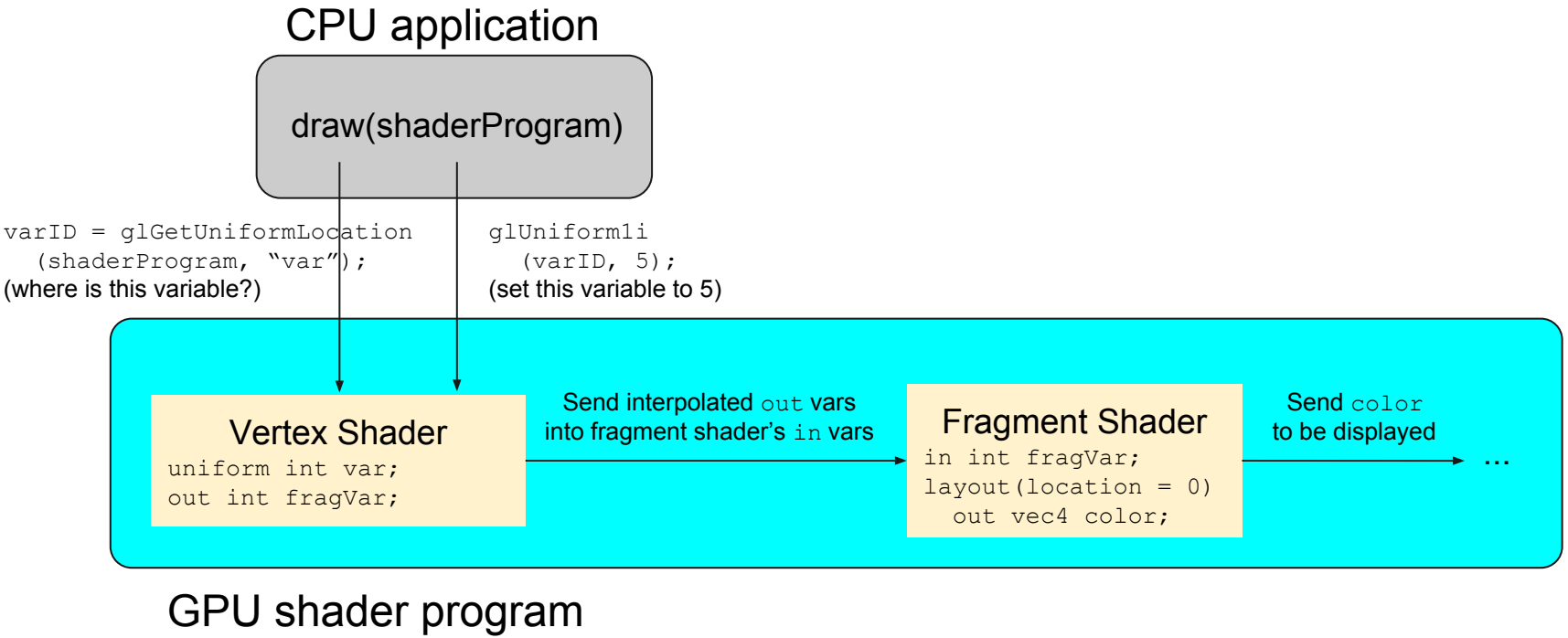
$$\sum_{n=0}^{spotlights-1} [k_a L_a + diffuse\_and\_specular]$$

$$diffuse\_and\_specular = \begin{cases} \frac{(\widehat{spot\_dir} \cdot \widehat{-l})^{spot\_exp}}{cd^2}(k_d L_d * max(0, (\widehat{n} \cdot \widehat{l})) + k_s L_s * max(0, (\widehat{r} \cdot \widehat{v}))^{\alpha}) & if \arccos(\widehat{spot\_dir} \cdot \widehat{-l}) \leq spot\_cutoff \\ 0 & otherwise \end{cases}$$

OpenGL Pipeline, again

- Transferring data from CPU to GPU is slow
- Do it once and don’t have the overhead
  - `glGetUniformLocation`
  - `glUniform*`
- Once in the GPU, send data from shader to shader without revisiting CPU
  - Vertex shader’s `out` → Fragment shader’s `in`
  - (Some interpolation will happen)

OpenGL Pipeline, again



Directional Light

DirectionalLight.cpp

```
void DirectionalLight::bind(GLuint shaderProgram)
{
  GLuint lightAttrID = glGetUniformLocation(shaderProgram,
    "dirLight.on");
  glUniform1i(lightAttrID, on);
  lightAttrID = glGetUniformLocation(shaderProgram,
    "dirLight.dir");
  glUniform3fv(lightAttrID, 1, &direction[0]);
}
```

shader.vert

```
...
uniform struct DirLight {
  bool on;
  vec3 dir;
} dirLight;

out DirLight fragDirLight;
...
void main()
{
  fragDirLight = dirLight;
  ...
}
```

Directional Light

shader.vert

```
...
uniform struct DirLight {
  bool on;
  vec3 dir;
} dirLight;

out DirLight fragDirLight;
...
void main()
{
  fragDirLight = dirLight;
  ...
}
```

shader.frag

```
...
in struct DirLight {
       bool on;
       vec3 dir;
} fragDirLight;
...
void main()
{
  if (fragDirLight.on)
  {
     //Do directional light calculation
  }
  ...
}
```