计算机图形学 Homework 6 - Lights and Shading

16340299 赵博然

场景中绘制 cube.

顶点坐标数组.

```
float vertices[] = {
    -2.0f, -2.0f, -2.0f, 1.0f, 0.0f, 0.0f,
    2.0f, -2.0f, -2.0f, 1.0f, 0.0f, 0.0f,
    2.0f, 2.0f, -2.0f, 1.0f, 0.0f, 0.0f,
    2.0f, 2.0f, -2.0f, 1.0f, 0.0f, 0.0f,
    -2.0f, 2.0f, -2.0f, 1.0f, 0.0f, 0.0f,
    -2.0f, -2.0f, -2.0f, 1.0f, 0.0f, 0.0f,

    -2.0f, -2.0f, 2.0f, 0.0f, 1.0f, 0.0f,
    2.0f, -2.0f, 2.0f, 0.0f, 1.0f, 0.0f,
    2.0f, 2.0f, 2.0f, 0.0f, 1.0f, 0.0f,
    2.0f, 2.0f, 2.0f, 0.0f, 1.0f, 0.0f,
    -2.0f, 2.0f, 2.0f, 0.0f, 1.0f, 0.0f,
    -2.0f, -2.0f, 2.0f, 0.0f, 1.0f, 0.0f,

    -2.0f, 2.0f, 2.0f, 0.0f, 0.0f, 1.0f,
    -2.0f, 2.0f, -2.0f, 0.0f, 0.0f, 1.0f,
    -2.0f, -2.0f, -2.0f, 0.0f, 0.0f, 1.0f,
    -2.0f, -2.0f, -2.0f, 0.0f, 0.0f, 1.0f,
    -2.0f, -2.0f, 2.0f, 0.0f, 0.0f, 1.0f,
    -2.0f, 2.0f, 2.0f, 0.0f, 0.0f, 1.0f,

    2.0f, 2.0f, 2.0f, 0.0f, 1.0f, 1.0f,
    2.0f, 2.0f, -2.0f, 0.0f, 1.0f, 1.0f,
    2.0f, -2.0f, -2.0f, 0.0f, 1.0f, 1.0f,
    2.0f, -2.0f, -2.0f, 0.0f, 1.0f, 1.0f,
    2.0f, -2.0f, 2.0f, 0.0f, 1.0f, 1.0f,
    2.0f, 2.0f, 2.0f, 0.0f, 1.0f, 1.0f,

    -2.0f, -2.0f, -2.0f, 1.0f, 0.0f, 1.0f,
    2.0f, -2.0f, -2.0f, 1.0f, 0.0f, 1.0f,
    2.0f, -2.0f, 2.0f, 1.0f, 0.0f, 1.0f,
    2.0f, -2.0f, 2.0f, 1.0f, 0.0f, 1.0f,
    -2.0f, -2.0f, 2.0f, 1.0f, 0.0f, 1.0f,
    -2.0f, -2.0f, -2.0f, 1.0f, 0.0f, 1.0f,

    -2.0f, 2.0f, -2.0f, 1.0f, 1.0f, 0.0f,
    2.0f, 2.0f, -2.0f, 1.0f, 1.0f, 0.0f,
    2.0f, 2.0f, 2.0f, 1.0f, 1.0f, 0.0f,
    2.0f, 2.0f, 2.0f, 1.0f, 1.0f, 0.0f,
    -2.0f, 2.0f, 2.0f, 1.0f, 1.0f, 0.0f,
    -2.0f, 2.0f, -2.0f, 1.0f, 1.0f, 0.0f,
};
```

使用 Homework 3 的方法绘制 cube.

Phong 光照模型.

顶点着色器 phong.vs. 在顶点着色器计算 Frag 的位置和 FragPos 和法向量 Normal.

```
#version 330 core
layout(location = 0) in vec3 aPos;
layout(location = 1) in vec3 aNormal;

uniform mat4 model;
uniform mat4 view;
uniform mat4 projection;

out vec3 Normal;
out vec3 FragPos;
out vec3 result;


void main() {
  FragPos = vec3(model * vec4(aPos, 1.0));
  gl_Position = projection * view * model * vec4(aPos, 1.0);
  Normal = mat3(transpose(inverse(model))) * aNormal;
}
```

片段着色器 phong.fs. 在片段着色器计算 ambient, diffuse, specular.

```
#version 330 core
in vec3 Normal;
in vec3 FragPos;
out vec4 FragColor;

uniform vec3 objectColor;
uniform vec3 lightColor;
uniform vec3 lightPos;
uniform vec3 viewPos;
uniform float ambientStrength;
uniform float specularStrength;
uniform float shininess;
uniform float diffuseMultiple;

void main() {
  vec3 ambient = ambientStrength * lightColor;
  vec3 norm = normalize(Normal);
  vec3 lightDirection = normalize(lightPos - FragPos);
  vec3 viewDirection = normalize(viewPos - FragPos);
  vec3 reflectDirection = reflect(-lightDirection, norm);

  float diff = max(dot(norm, lightDirection), 0.0);
  vec3 diffuse = diff * lightColor;

  float spec = pow(max(dot(viewDirection, reflectDirection), 0.0), shininess);
  vec3 specular = specularStrength * spec * lightColor;

  FragColor = vec4((ambient + diffuseMultiple * diffuse + specular) * objectColor,
1.0);
}
```

Gouraud 光照模型. Gouraud 在顶点着色器中计算光照模型, 然后在片段着色器中插值计算颜色. 光照模型的计算与 Phong 基本相同.

顶点着色器 gouraud.vs.

```
#version 330 core
layout(location = 0) in vec3 aPos;
layout(location = 1) in vec3 aNormal;

uniform mat4 model;
uniform mat4 view;
uniform mat4 projection;

uniform vec3 lightColor;
uniform vec3 lightPos;
uniform vec3 viewPos;

uniform float ambientStrength;
uniform float specularStrength;
uniform float diffuseMultiple;
uniform float shininess;

out vec3 result;

void main() {
  gl_Position = projection * view * model * vec4(aPos, 1.0);

  vec3 FragPos = vec3(model * vec4(aPos, 1.0));
  vec3 Normal = mat3(transpose(inverse(model))) * aNormal;
  vec3 norm = normalize(Normal);
  vec3 lightDirection = normalize(lightPos - FragPos);
  vec3 viewDirection = normalize(viewPos - FragPos);
  vec3 reflectDirection = reflect(-lightDirection, norm);

  vec3 ambient = ambientStrength * lightColor;

  float diff = max(dot(norm, lightDirection), 0.0);
  vec3 diffuse = diff * lightColor;

  float spec = pow(max(dot(viewDirection, reflectDirection), 0.0), shininess);
  vec3 specular = specularStrength * spec * lightColor;

  result = ambient + diffuseMultiple * diffuse + specular;
}
```

片段着色器 gouraud.fs.

```
#version 330 core
in vec3 result;
out vec4 FragColor;

uniform vec3 objectColor;

void main()
{
    FragColor = vec4(result * objectColor, 1.0);
}
```

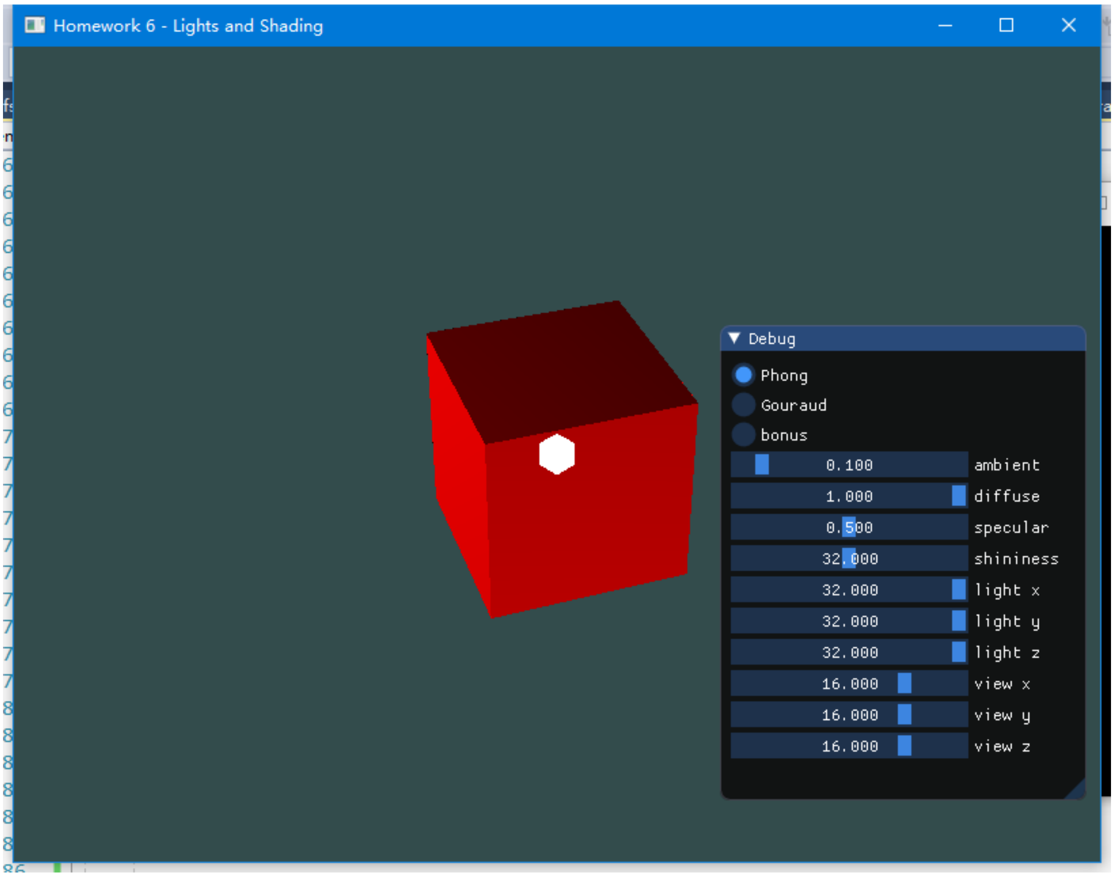
使光源移动.

在 ImGui 中调节光源位置. 另外使光源可以随时间自动绕 y 轴旋转. 我还设置了调节摄像机位置方便观察.

```
ImGui::SliderFloat("light x", &lightPosition.x, -32.0f, 32.0f);
ImGui::SliderFloat("light y", &lightPosition.y, -32.0f, 32.0f);
ImGui::SliderFloat("light z", &lightPosition.z, -32.0f, 32.0f);.
ImGui::SliderFloat("view x", &viewPosition.x, -32.0f, 32.0f);
ImGui::SliderFloat("view y", &viewPosition.y, -32.0f, 32.0f);
ImGui::SliderFloat("view z", &viewPosition.z, -32.0f, 32.0f);
float radius = 32.0f;
float camX = sin(glfwGetTime()) * radius;
float camZ = cos(glfwGetTime()) * radius;
```

截图.

Phong 光照模型.

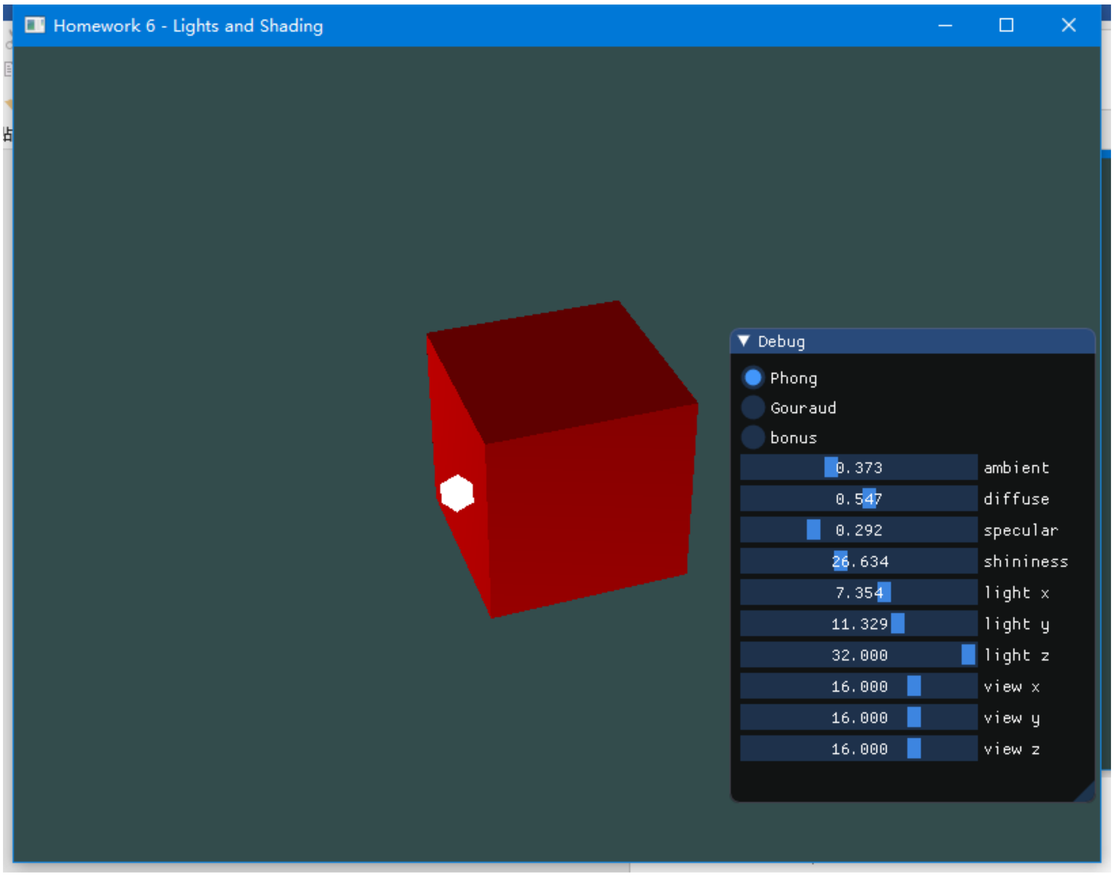


Debug

● Phong
○ Gouraud
○ bonus

```
0.100   ambient
1.000   diffuse
0.500   specular
32.000  shininess
32.000  light x
32.000  light y
32.000  light z
16.000  view x
16.000  view y
16.000  view z
```

移动光源，改变参数.



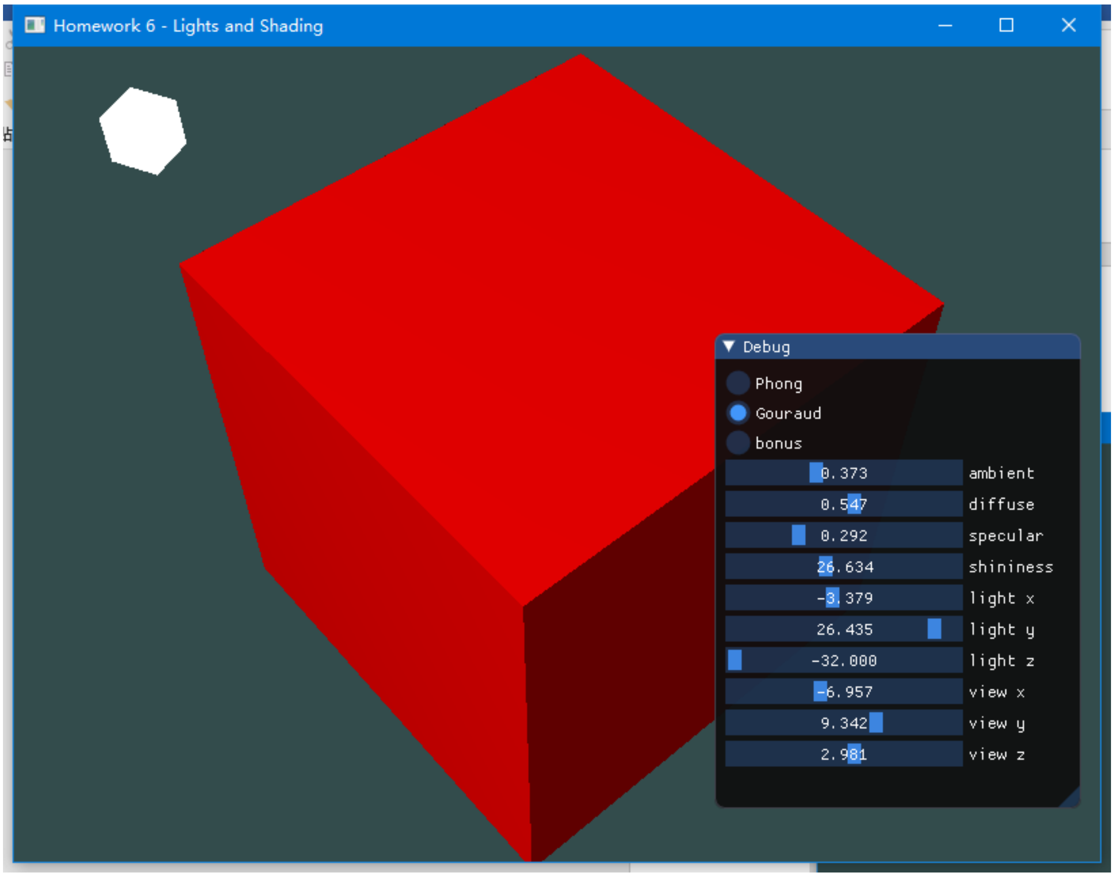
Homework 6 - Lights and Shading

Debug

● Phong
○ Gouraud
○ bonus

```
 0.373   ambient
 0.547   diffuse
 0.292   specular
26.634   shininess
 7.354   light x
11.329   light y
32.000   light z
16.000   view x
16.000   view y
16.000   view z
```

Gouraud 光照模型．看上去与 Phong 没有太大区别．



Homework 6 - Lights and Shading

Debug

○ Phong
● Gouraud
○ bonus

```
  0.373   ambient
  0.547   diffuse
  0.292   specular
 26.634   shininess
 -3.379   light x
 26.435   light y
-32.000   light z
 -6.957   view x
  9.342   view y
  2.981   view z
```

bonus 部分见 video.mp4.

代码见 src/main.cpp.
程序见 doc/program/program.exe.
演示视频见 doc/video.mp4.