Summer 2020
CS 300 | Advanced Computer Graphics I
Assignment 1 | Phong Illumination Model

Description

In this assignment, the main task to apply the Phong illumination model on the shapes created for assignment 0.

For this programming assignment you need to the following:

- **Shader Management**
  - Shader code MUST be loaded from an external file, i.e. you must NOT embed the shader code within your C++ code.
  - Compile and install the shader code to be used. Should the shader/program fail to compile or link, you must print out the error messages to the console or the main window.
  - The error message MUST specify which shader file(s) is causing the problem. (**Hint**: implement a *Shader Manager* class that encapsulates the one or more program objects – a program object contains a vertex and a fragment shader; also think that you might want to support more than one shader program in your application).

- **Shader programs**
  - You need to write the vertex and fragment shaders that implement the Phong illumination model with support for point, spot and directional light source types.
    - In the vertex shader:
      - Transform the geometry vertices from the model space to the homogenous clip space.
      - Calculate all required out variables for the lighting calculation and pass them to the fragment shader.
    - In the fragment shader:
      - Set up the texture samplers for diffuse and specular components.
      - Sample the appropriate texture for each material coefficient.
      - Set up the uniforms for the application to pass in lighting properties and other settings.
      - Implement the phong lighting equations explained in class.
    - EXTRA CREDIT: support 8 lights simultaneously (15%).

- **Material Properties**
  - Material will contain 3 main properties and a texture:
    - Texture to map on shape (when texturing is disabled use UV as color)
    - Diffuse color
    - Specular color
    - Shininess

- **Light Properties**
  - Depending on the type of light you will need to specify:
    - Type of light
    - Its position and/or direction.
    - Global ambient color.
    - Ambient, diffuse and specular colors.
    - Attenuation coefficients (for the spotlights this includes the angular attenuation parameters).

- **Scene Setup**
  - Render a 50x50 units 2D plane aligned with the XZ plane and 15 units under the origin, i.e. the center is at (0,−15,0) and normal is (0,1,0).
  - Render one shape with size 10x10 at a time (from the shape library), arrows keys will rotate that shape.
  - Place the light(s) equally spaced along a circle centered at (0,0,0) with radius of 20 and have them rotate slowly around the Y axis. While rotating they should move up/down in a sinusoidal manner along the Y axis.
  - If light type is spotlight or directional, have them look at the object center, i.e. the light(s) follows the object center.
  - Apply the shader to both the object and the plane.
  - Render a small sphere (radius = 1) to represent where the light(s) is (do not apply the shader on these spheres, they should be always white).

- **Input Handling**
  - Move the camera around in always looking at the object.
    - W: Move up.
    - S: Move down.
    - A: Move left.
    - D: Move right.
    - E: Closer to object.
    - Q: Further from object.

  - Select shape to be rendered through the number keys.
    - Numbers 1 to 5: Change the shape to be rendered
      - 1: Plane
      - 2: Cube
      - 3: Cone
      - 4: Cylinder
      - 5: Sphere

  - Select the light types:
    - L: All lights become point lights.
    - K: All lights become spot lights.
    - J: All lights become directional lights.

  - P: Toggle to pause/start the light animation.

- N: Toggle normal rendering
- T: Toggle texture-mapping on/off

- Object rotation for center shape.
  - Arrows Up/Down: Rotate the shape along Y-axis
  - Arrows Right/Left: Rotate the shape along X-axis

- EXTRA CREDIT: Select the number of lights to be used in the scene (Required for extra).
  - I: Add light (maximum of 8 lights)
  - R: Remove all lights

Assignment Submission

Please refer to the syllabus for assignment submission guideline. Failure to the submission guidelines correctly might cause you to lose point.

Grading Rubrics

The following is a rough guideline on how your assignment will be graded and the weight of each part.

- Shaders 15%.
- Material 10%.
- Correct implementation of the lighting equation components 65%.
  - Ambient 5%
  - Diffuse 20%
  - Specular 30%
  - Attenuation 10%
- Scene setup and user controls 10%.