

Assignment 3

COMP 4002
Date: November 5 2014

Due: on November 16, 2014 before 22:00 (10:00 PM)
Submission: Electronic submission on CULearn.

Assignment Objectives:

- a. Familiarization with lighting models
- b. Familiarization with light sources
- c. Familiarization with the type of required matrices for the transformation-
 - i. Vertex position for lighting computation
 - ii. Vertex position required by OpenGL (gl_position)
 - iii. Vertex Normals
 - iv. Output colour computation (gl_Fragcolor)

Grades:

1. Assignment total marks: 100%.

1. Task 1 – Create A Gouraud light model (40)

Purpose:

- a. Create a Gouraud light model
- b. Experiment with the different component of light

To do:

1. Create a project and modify code. (use code from Assignment 2)
 - 1.1. Create a sphere with a few sides and place it on the world space on the xz plane at 100, 10, 100.
 - 1.2. Set up a view position (e.g., 200,200,200) and set up the transformation matrix so that you can see the sphere.
 - 1.3. Set up perspective projection (e.g., symmetric).
 - 1.4. Object material colour is -
 - 1.4.1. Ambient (0.8, 0.4,0.2)
 - 1.4.2. Diffuse (0.75, 0.75, 0.5)
 - 1.4.3. Specular (0.8, 0.8,0.8)
 - 1.5. Level of shininess is 5
 - 1.5.1. Allow user to change the level of shininess by:
 - 1.5.1.1. '+' – increases the level of shininess by 5
 - 1.5.1.2. '-' – decreases the level of shininess by 5 (note minimum should be 1 or 0)

- 1.6. Display the sphere.
2. Use from Assignment 2 - Create a camera class that will enable the user to manipulate the camera.
 - 2.1. Keep with the camera three variables: position, look at vector or (reference point), and up vector.
 - 2.2. The user can manipulate the camera as follows:
 - 2.2.1. Pitch operation – the up and down arrow keys will rotate the camera around the x-axis by +1 degree and -1 degree respectively.
 - 2.2.2. Yaw operation – the left and right arrow keys will rotate the camera around the y-axis by +1 degree and -1 degree respectively.
 - 2.2.3. Roll operation – the “a” and “d” keys will rotate the camera around the z-axis by +1 degree and -1 degree respectively.
 - 2.2.4. Forward motion – the “w” key will move the camera forward by 1 unit along the “look at” vector.
 - 2.2.5. Backward motion - the “s” key will move the camera backward by 1 unit along the “look at” vector.
3. Create a Gouraud model
 - 3.1. The light model should have all three light components – ambient, diffuse, specular
 - 3.2. Allow the user to turn the light component on and off by toggling the keys
 - 3.2.1. ‘M’ – turn ambient light off
 - 3.2.2. ‘m’ – turn ambient light on
 - 3.2.3. ‘N’ – turn diffuse light off
 - 3.2.4. ‘n’ – turn ambient light on
 - 3.2.5. ‘B’ – turn specular light off
 - 3.2.6. ‘b’ – turn specular light on
4. Light properties
 - 4.1. Create a point light source
 - 4.1.1. The position of the light source is at 200,210,200
 - 4.2. Light colours
 - 4.2.1. The colour of the light source of all three sources should be white
 - 4.2.1.1. Allow user to change the colour of the light sources by pressing the character ‘c’ –
 - 4.2.1.1.1. ambient colour to (0, 1.0, 0.5)
 - 4.2.1.1.2. diffuse colour to (0.7, 0, 0.7)
 - 4.2.1.1.3. specular light to (1, 0, 0)
 - 4.2.1.2. Pressing ‘C’ will change the colours back to white
5. Scaling
 - 5.1. Allow the user to scale the sphere in the x and y directions using the i,j,k,l keyboard strokes –
 - 5.1.1. Pressing on ‘i’ means increment the scale in the x-direction by 0.5 increments;

- 5.1.2. Pressing on 'j' means decrement the scale factor in the x-direction by 0.5. Min scale is 1;
- 5.1.3. Pressing on 'k' means increment the scale in the y-direction by 0.5 increments;
- 5.1.4. Pressing on 'l' means decrement the scale factor in the y-direction by 0.5. Min scale is 1;
- 5.1.5. Pressing on 'r' resets the scale in the x,y,z directions to 1.

2. Task 2 – Create a Phong Lighting model (40)

Purpose:

- a. Be familiar with the Phong Model

To do:

- 6. Create a Phong model
 - 6.1. Use a new shader program. Namely, there should be two shader programs one for Phong and one for Gouraud
 - 6.2. The light model should have all three light components – ambient, diffuse, specular
 - 6.3. Allow the user to change the light colour properties
 - 6.4. Allow the user to turn the light component on and off by toggling the keys
 - 6.4.1. 'M' – turn ambient light off
 - 6.4.2. 'm' – turn ambient light on
 - 6.4.3. 'N' – turn diffuse light off
 - 6.4.4. 'n' – turn ambient light on
 - 6.4.5. 'B' – turn specular light off
 - 6.4.6. 'b' – turn specular light on
- 7. Allow the user to manipulate the scaling factors
- 8. Allow the user to switch between the Phong model and the Gouraud model
 - 8.1. 'p' or 'P' – use Phong model
 - 8.2. 'g' or 'G' – use Gouraud model

3. Task 3 – Compare the lighting models (10)

- 9. Compare the two models and state your opinion:
 - 9.1. Which model is better? Why?
 - 9.2. To your opinion is it worth to use the Phong model from performance point of view and from programming efforts point of view?

4. Task 4 – Perform bilinear interpolation (10)

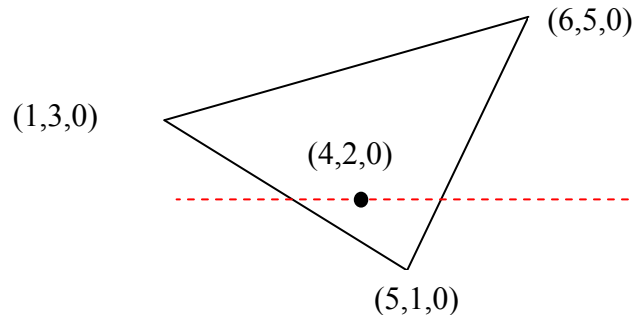
- 10. Assume that vertex shader has computed the following values at vertices v1, v2, v3:
 - V1 – position(5,1,0), (colour (0.9, 0.7, 0.1), normal(1, 3, 3))

- V2 – position(5,1,0), colour (1.0, 0.3, 0.9), normal(2, 2, 2)
- V3 – position(5,1,0), colour (1.0, 1.0, 0.1), normal(0, 2, 2)

Assume that:

- Colour and normal are declared as varying at the vertex shader and the fragment shader.
- The fragment shader is currently processing a fragment at position (4,2,0).

What values of colour and normal be transferred to the fragment shader by the GPU?



5. Bonus – Create a second light source

6. Render a “robot arm” complex hierarchical object (25)

1. Create a second light source which is a spot light.
2. The light cone angle should start at 35 degrees.
 - 2.1. Allow the user to control the light cone by pressing
 - 2.1.1. ‘0’ – to increase the cone opening angle in increments of 1 degree. Max angle is 120.
 - 2.1.2. ‘9’ – to decrease the cone opening angle in increments of 1 degree. Min angle is 1
3. Allow the user to control the light focus intensity (angular attenuation)
 - 3.1. ‘8’ – to increase the cone opening angle in increments of 3.
 - 3.2. ‘7’ – to decrease the cone opening angle in increments of 3. Min value is 1 or 0
4. The spot light source should be aimed towards the centre of the sphere
5. The spot light should be positioned at (190, 200, 190)
6. Time permitted add radial attenuation