MUĞLA SITKI KOÇMAN UNIVERSITY

CENG 3547 INTRODUCTION TO COMPUTER GRAPHICS

FALL 2020-2021

HOMEWORK 1

HAND OUT: 10/11/2020

DUE DATE: 24/11/2020, 23.59

Notice that the first 4 questions are written, and the 5th and 6th questions are programming assignment. Solutions of written questions will be prepared as a single pdf file (scanned file of a hand-written solution is accepted). Together with the .c files of 5th and 6th questions, zip this pdf file and send it via DYS in time!!!

NO JOINT WORK IS ALLOWED. LATE SUBMISSIONS ARE NOT ACCEPTED!!

WRITTEN PART

Question 1) Raster images. Order the following three images by how much memory they occupy:

1024 by 1024 binary image 1 bit per pixel

2048 by 2048 grayscale image with 256 gray levels

512 by 512 color image with 256 levels in each color component

Question 2) Suppose we have two monitors, A and B. Monitor A has $\gamma = 1.5$ while Monitor B has $\gamma = 3$. They both accept input quantized in the same way (if it helps, assume 256 equal steps from 0 to 1). Both monitors have the same maximum intensity, and they produce exactly zero light for pixels that are turned completely off.

1. If we display the same image on both monitors, which will produce a darker-looking output?

2. Which monitor gives better intensity resolution in the darkest parts of the image?

Question 3) 2D Geometry. Write down the 3x3 homogeneous matrices for the following affine transformations. Your answer should be an array of 9 numbers in each case.

a translation by 3 along x and 2 along y

a counterclockwise rotation by 45 degrees about the origin

a scale by 1.4 along the x axis

a counterclockwise rotation by 30 about the origin followed by a translation by 4 along the x axis

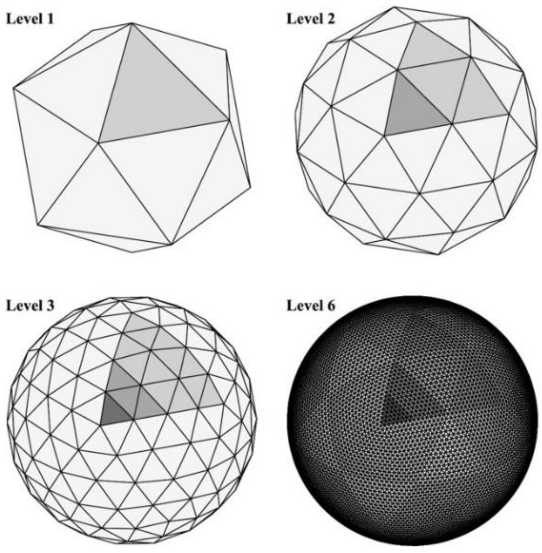
a translation by 4 along the x axis followed by a counterclockwise rotation by 30 degrees about the origin

a counterclockwise rotation by 30 degrees about the point(4,0)

Question 4) Affine Transformation. Write the 4x4 matrix for this affine transformation: A viewing transformation for a camera at the position (0,3,4) looking at the origin with up vector (0,1,0). It is OK to use a matrix inverse in your answer.

PROGRAMMING PART

Question 5) SPHERE TESELLATION FROM ICOSAHEDRON



See [1].

In this programming assignment, you are asked to tesellate a sphere from a simple icosahedron. Your sphere will be able to tesellated for different levels that are handled recursively.

You can use a vector class or build your own to keep the vertices.

Hint – you can define the vertices as:

```
const float A=.525f;
const float B=.850f;
const float C=0.0f;

static GLfloat vert[12][3]=
{
  {-A,C,B}, {A,C,B}, {-A,C,-B}, {A,C,-B},
  {C,B,A}, {C,B,-A}, {C,-B,A}, {C,-B,-A},
  {B,A,C}, {-B,A, C}, {B,-A,C}, {-B,-A, C}
};

static GLuint tri[20][3] =
{
  {0,4,1},{0,9,4},{9,5,4},{4,5,8},{4,8,1},
  {8,10,1},{8,3,10},{5,3,8},{5,2,3},{2,7,3},
  {7,10,3},{7,6,10},{7,11,6},{11,0,6},{0,1,6},
  {6,1,10},{9,0,11},{9,11,2},{9,2,5},{7,2,11}
};
```

Please be careful. Orientation is important!!

Now, draw the triangles.

Calculate the normal vectors by taking the normalized cross product of any two sides and normalize the normals for shading

Tesellation Algorithm:

Recursively subdivide by taking the midpoints as: (v1+v2)/2.

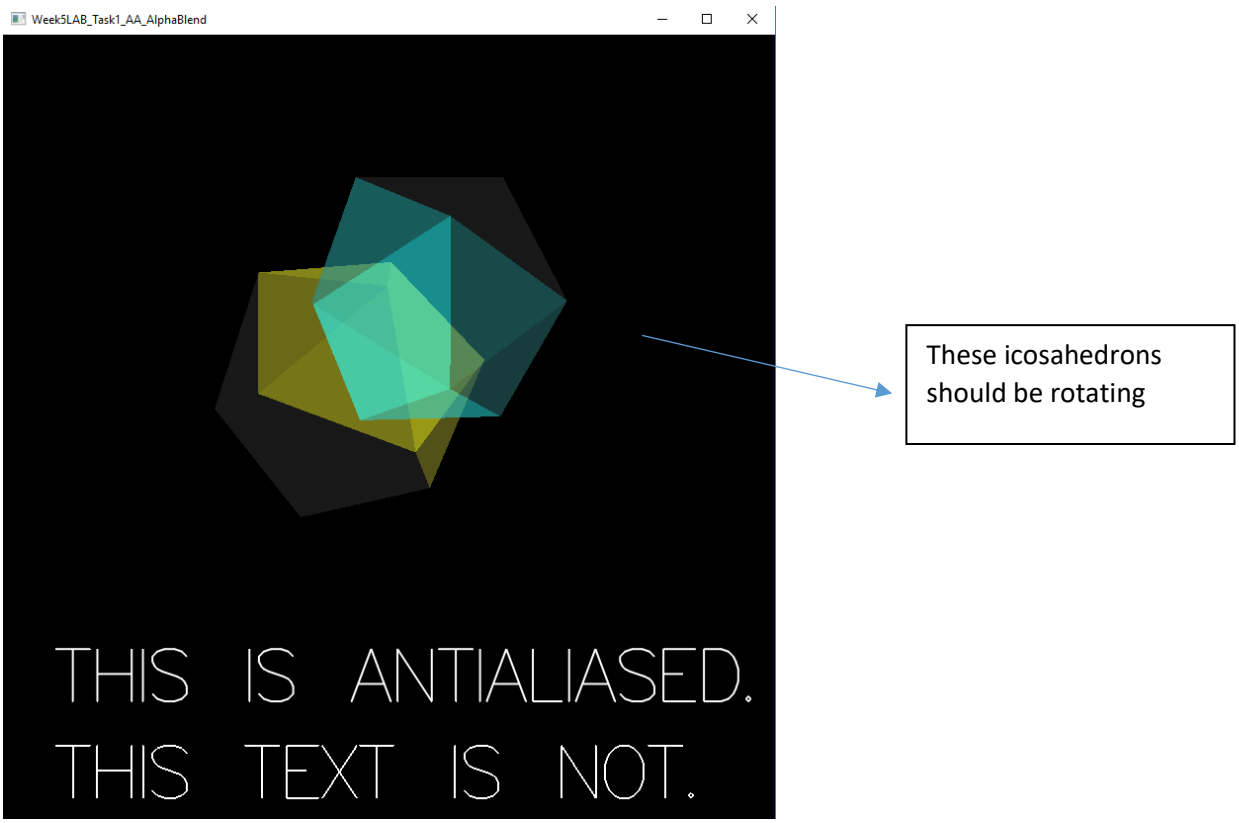
References

[1]: Simmons et al. Global-scale P wave tomography optimized for prediction of teleseismic and regional travel times for Middle East events: 2. Tomographic inversion. Journal of Geophysical Research Atmospheres, 2011.

Question 6) GRAPHICS PIPELINE

Read the brief information below and follow the given instructions in the TODO sections of both source codes to complete your tasks.

6.1 – Observe how alpha blending and antialiasing work in OpenGL. The output will be:



6.2 – We have three objects in the scene. A torus, a teapot and an icosahedron. Our program will be able to assign different materials to these objects. E.g.

- Red plastic
- Emerald
- Brass
- Slate

Besides, our program should:

- Enable left and right lights with color red, white or green
- Disable lights
- Use a shade model: flat