Computer Graphics: HW #3 Real-time Rendering a Polygonal Mesh with Modern OpenGL

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Abstract

In this assignment, we implement a program written in Moden OpenGL (i.e., OpenGL 2.x or higher) using shaders, in order to render a polygonal mesh in real-time.

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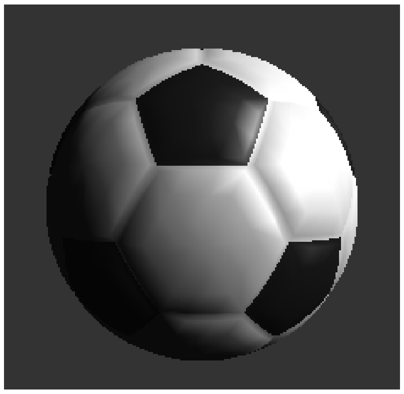

1 Introduction

The goal of this assignment is to implement real-time rendering of a polygonal mesh with OpenGL lighting and shading. From this assignment, you will learn about the following concepts.

1) How to parse OBJ file format.
2) How to maintain polygonal mesh data in your program.
3) How to render a polygonal mesh model with the Phong reflection model by using Modern OpenGL.

Write a GLUT program which can load an obj file format, and rendering it by shading proper materials and OpenGL lighting. Your program must accept an OBJ filename as an argument as follows.

```
./obj_viewer data/cube.obj
```

2 OBJ file

We assume that the polygonal mesh data is provided by the Alias|Wavefront OBJ file-format. Each OBJ file-format has the following information about a polygonal mesh.

- Vertex positions (mandatory)
- Vertex normals (optional)
- Vertex texture-coordinates (optional: in this assignment, we *ignore* this term.)
- Face information (mandatory)
- Group information (optional)
- Material information (optional)

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The following is a simple example of an OBJ file which describes a cube.

```
mtllib cube.mtl

v  0.0  0.0  0.0
v  0.0  0.0  1.0
v  0.0  1.0  0.0
v  0.0  1.0  1.0
v  1.0  0.0  0.0
v  1.0  0.0  1.0
v  1.0  1.0  0.0
v  1.0  1.0  1.0

vn  0.0  0.0  1.0
vn  0.0  0.0 -1.0
vn  0.0  1.0  0.0
vn  0.0 -1.0  0.0
vn  1.0  0.0  0.0
vn -1.0  0.0  0.0

g back
usemtl back
f  1//2  7//2  5//2
f  1//2  3//2  7//2
g left
usemtl left
f  1//6  4//6  3//6
f  1//6  2//6  4//6
g top
usemtl top
f  3//3  8//3  7//3
f  3//3  4//3  8//3
g right
usemtl right
f  5//5  7//5  8//5
f  5//5  8//5  6//5
g bottom
usemtl bottom
f  1//4  5//4  6//4
f  1//4  6//4  2//4
g front
usemtl front
f  2//1  6//1  8//1
f  2//1  8//1  4//1
```

The first line depicts the name of material file, which contains the information about one or more material properties used in the OBJ file. We assume that the material file exists in the same directory where the OBJ file exists.

Each line stars with 'v', 'vn', 'f', or 'g', where each is an abbreviation of the information about a polygonal mesh data.

- v: vertex position
- vn: vertex normal
- f: face information
- g: group information

In the cube example, the OBJ file contains 8 vertex positions, 4 vertex normals, 12 faces, 6 groups.

Each line starting with 'v' (resp. 'vn') represents the position of each vertex. According to the order of 'v's (resp. 'vn's), the indices of the vertex positions (resp. vertex normals) are implicitly numbered with 1, 2, 3, ... and so on. This implicit numbers about the vertex positions (resp. vertex normals) will be used later, in specifying the face information.

Each group consists of one or more faces, where the faces in a group share the same material properties. In the OBJ file, the material property for a group is specified by "usemtl [material_name]". You can assume that [material_name] must exist in the material file, which is specified by "mtllib [material_filename]". In the case that there is no specification about the material property for a group or there is no such a file of [material_filename] in the directory, you have to use your own default material property.

Each face consists of three or more vertices. Each vertex in a face is represented with proper indices of position and normal. For example, the line of "f 1//2 7//2 5//2" tells us that a face consists of three vertices, where

1) The position of three vertices are (0, 0, 0), (1, 1, 0), (1, 0, 0), respectively
2) The normal of three vertices is same as (0, 0, -1).

3 Material File

The following is a simple example of material file format (*.mtl).

```
#
#  cube.mtl  (comments)
#

newmtl front
Ka 0.4000 0.4000 0.4000
Kd 0.0000 0.2000 1.0000
Ks 0.5000 0.5000 0.5000
Ns 60.0000


newmtl back
Ka 0.4000 0.4000 0.4000
Kd 0.0000 0.5000 1.0000
Ks 0.7000 0.7000 0.7000
Ns 65.8900


newmtl dolph03
Ka 0.4000 0.4000 0.4000
Kd 0.0000 0.7000 0.8000
Ks 0.7000 0.7000 0.7000
Ns 60.0000

...
```

Each line starting with "newmtl [material_name]" represents that there is a new material whose name is '[material_name]'. Recall that this material name is dereferenced by the line of "usemtl [material_name]" in the OBJ file. "Ka [coeff_red] [coeff_green] [coeff_blue]" stands for the coefficients of the ambient reflection. In the same manner, "Kd . . . " and "Ks . . . " stands for the coefficients of the diffuse reflection and specular reflection, respectively. "Ns [coeff]" stands for the shininess value of the specular reflection.

4 Specification

You don't need to implement all specifications about the OBJ file format and its material file format. It is non-trivial to implement an OBJ file viewer, which can handle all specifications about the OBJ file format. Instead of handing all specifications, in this assignment, you just concentrate on the options described above, such as 'v', 'vn', 'f', 'g', 'usemtl', 'mtllib' in an OBJ file and 'newmtl', 'Ka', 'Kd', 'Ks', 'Ns' in a material file. If you meet the other options, you MUST ignore them. It means your program SHOULD NOT be crashed by the other options.

5 Light Position

Feel free to define your own light position or direction in your program.

6 References

- OBJ file format
  - Wavefront .obj file (wikipedia)
  - Wavefront OBJ File Format Summary
- Material file format
  - MTL Specification

7 Due and Misc. (EXTREMELY IMPORTANT!!!)

- Your source codes must be written in a Moden OpenGL (i.e., OpenGL 2.x or higher) with shader programming.
- Your homework must be submitted to **가상강의실** until 23:59 on Jun. 3, in the form of OOOOOOOO_assign03.tar.gz (i.e., based on **standard zip** or **tar.gz**) containing the followings
  - Source files (*.h, *.cpp)
  - Makefile
- **The submitted source codes should be compiled on CentOS7.**
- Please, utilize the office hours when you have any question about the homework.