Computer Graphics Assignment 2: Obj viewer & drawing a hierarchical model

Handed out: April 12, 2021

Due: 23:59, May 9, 2021 (NO SCORE for late submissions!)

- *Only accept answers submitted via git push to this course project for you at https://hconnect.hanyang.ac.kr (<Year>_<Course no.>_<Class code>/<Year>_<Course no.>_<Student ID>.git).*
- *Place your files under the directory structure **<Assignment name>/<your files>** just like the following example.*

```
+ 2020_ITE0000_2019000001
  + ClassAssignment1/
    - main.py
    - report.docx
```

- *The submission time is determined not when the commit is made but when the git push is made.*

1. Implement your own obj file viewer 1) showing a single loaded obj mesh and 2) showing an animation of a hierarchical model consisting of loaded obj meshes. The multiple light sources should be used for rendering.
   A. You have to implement all requirements in a single program. This assignment DOES NOT require each requirement to be a separate program.
   B. The window size doesn't need to be (480, 480). Use the larger window that is enough to see the details of the viewer.
   C. Your program should run in two modes – "single mesh rendering mode" and "animating hierarchical model rendering mode"
   D. **DO NOT** set the window title to **your student ID**.
   E. Total points: 150 pts (+20 pts for extra credits)

2. Requirements

A. Manipulate the camera in the same way as in ClassAssignment1 using your ClassAssignment1 code (10 pts).

i. Also draw the reference grid plane.

B. Single mesh rendering mode (50 pts)

i. When a user does a drag-and-drop action on your viewer, your program should run in **"single mesh rendering mode"**.

ii. Open an obj file by drag-and-drop to your obj viewer window.

1. Google *glfwSetDropCallback* to see how to do it.

2. The viewer should render only one obj file at a time. If an obj file B is drag-and-dropped to the viewer while it is rendering another obj file A, the viewer should only render the new obj file B.

3. This feature is essential for scoring your assignment, so if not implemented, you won't get any score for "Single mesh rendering mode (50 pts)".

iii. Read the obj file and display the mesh only using vertex positions, vertex normals, faces information **(40 pts)**

1. Ignore texture coordinate, material, group, shading information. In other words, ignore vt, mtllib, usemtl, o, s tags.

2. Use glDrawArrays() or glDrawElements() to render triangle meshes.

A. **DO NOT use glVertex*() & glNormal*()**. If you draw meshes using glVertex*() & glNormal*(), you'll get only **10 pts** out of 40 pts.

iv. When open an obj file, print out the following information of the obj file to stdout (console) **(10 pts)**

1. File name

2. Total number of faces

3. Number of faces with 3 vertices

4. Number of faces with 4 vertices

5. Number of faces with more than 4 vertices

C. **Animating hierarchical model rendering mode (50 pts)**

i. *The content of this requirement will be covered in the next lecture (8 - Hierarchical Modeling).*

ii. When a user **presses a key 'h'** on your viewer, your program should run in **"animating hierarchical model rendering mode"**.

iii. The model should consist of **at least 3 different meshes loaded from 3 different downloaded obj files (10 pts)**.

1. **You MUST include the obj files used for this requirement in your submission and use "relative paths" to specify those files in your source code. Test your final submission files by putting them in a directory different from your working directory and run the program, before submit them. If this part of the program does not run normally for any reason, you won't get any score for "Animating hierarchical model rendering mode (50 pts)".**

2. Download cool public obj files from the Internet and use them. For example,

   A. https://free3d.com/

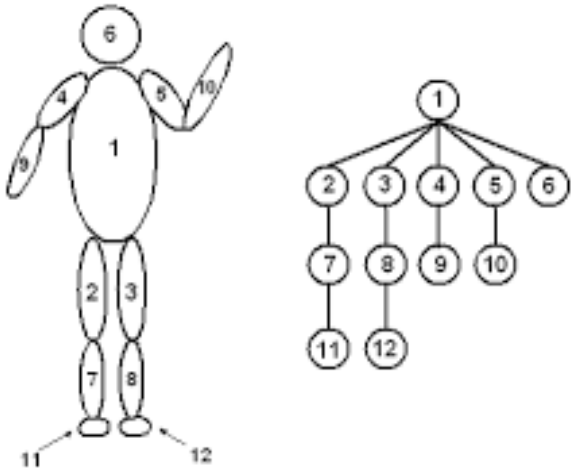
   B. https://www.cgtrader.com/free-3d-models

iv. **Do not use the provided sample obj files for this requirement.** You must use other obj files downloaded from internet to get score for this requirement. Otherwise, **you'll get -20 pts for this requirement.**

v. **You should use OpenGL matrix stack** to draw and animate your hierarchical model. **(10 pts)**.

vi. The model should have a **hierarchy of at least 3 levels (10 pts)**.

1. For example, the following model has a hierarchy of 4 levels.

2. 

vii. **Animate the model** to show the hierarchical structure **(20 pts)**.

1. Make all child body parts move relative to their own parent body part.

A. In the above example, part 2, 3, 4, 5, 6 should move relative to part 1, part 7 should move relative to part 2, part 11 should move relative to part 7, ... and so on.

B. If any of the child bodies does not move relative to its parent, you will get -10 pts.

2. You can make any hierarchical system freely. Be creative.

A. Eg) a hand with fingers bending

B. Eg) a runner with arms and legs swing

3. The model should be **automatically animated without any mouse or keyboard inputs.**

D. Lighting & Etc (20 pts)

i. Use multiple light sources (not a single light) to better visualize the meshes **(10 pts).**

1. Choose the number of light sources, light source types, light colors, material colors as you want.

ii. Toggle wireframe / solid mode by pressing **'z' key** (similar to pressing 'z' key in Blender) **(10 pts).**

1. glPolygonMode(GL_FRONT_AND_BACK, GL_LINE) # call this at the beginning of your render function to draw in wireframe mode.

3. Report (20 pts)

A. Submit a report of **at most 2 pages** in docx file format (MS Word). Do not exceed the limit.

B. The report should include:

i. Which requirements you implemented **(5 pts)**

ii. A hyperlink to the video uploaded to Internet video streaming services (such as YouTube and Vimeo) by capturing the animating hierarchical model as a video **(10 pts).**

1. **The uploaded video MUST be publicly accessible.** Otherwise, you won't get the 10 pts.

iii. Lighting configuration **(5 pts)**:

A. How many light sources?

B. Where do you put the light sources?

C. What is the type of each light source (point light or directional light)?

~~C.~~ You do not need to try to write a long report. Just only write down the required information. ~~Use either English or Korean.~~

4. Extra credits

A. Toggle [shading using normal data in obj file] / [forced smooth shading] by pressing **'s' key (+10 pts)**

i. In [forced smooth shading] mode, do not use vertex normal in obj. Instead, you have to compute the averaged vertex normal for each vertex as described in the lecture slide and use them for shading.

B. Load & render a mesh that does not have the same number of vertices of all polygons using glDrawArrays() or glDrawElements() **(+10 pts)**

i. For example, some polygons in the mesh are triangles and the rest are quads or polygons with more vertices

ii. To render this kind of mesh using a vertex array, you might need to render a quad or

a n-polygon as a set of triangles. So you may need some kind of "triangulation" algorithm.

5. Runtime Environment

A. Your program should be able to run on systems only with Python 3.7 or later, NumPy, PyOpenGL, glfw. Do not use any other additional python modules.

B. Only **glfw** is allowed for event processing and window & OpenGL context management. **Do not use glut functions for this purpose.**

C. If your program does not meet this requirement, it will not run on TA's computer so you will not get any score for this assignment (except report).

6. Sample obj files the "Single mesh rendering mode".

A. cube-tri.obj: A cube with triangles only

B. cube-tri-quad.obj: A cube with triangles and quads

C. sphere-tri.obj: A sphere with triangles only

D. sphere-tri-quad.obj: A sphere with triangles and quads

E. cylinder-tri.obj: A cylinder with triangles only

F. cylinder-tri-quad-n.obj: A cylinder with triangles, quads and polygons with more vertices

G. Basically, your viewer should be able to render cube-tri.obj, sphere-tri.obj, cylinder-tri.obj properly.

H. To meet the extra credit, your viewer should be able to render all above sample obj files properly.

7. What you have to submit:

A. **.py files**

i. You can use multiple .py files for this assignment. In this case, explain how to run the program in the report.

B. .obj files

i. The obj files used for "Animating hierarchical model rendering mode".

C. **.docx report file**

8. Additional information

A. *drop_callback* in glfw python binding is slightly different from that of original glfw written in C. *drop_callback* in python takes only two parameters, *window* and *paths*. *paths* is a list of dropped file paths.

B. obj file format reference: https://en.wikipedia.org/wiki/Wavefront_.obj_file

C. Python provides powerful string methods helpful for parsing an obj file. Among them, split() will be most useful.