Department of Computer Science

Faculty of Engineering, Built Environment & IT

University of Pretoria

# COS344 - Computer Graphics

# Homework Assignment Specification: Rendering of IT Kiosk

Release Date: 03-03-2025 at 06:00

Initial Report Due Date: 28-04-2025 at 23:59

Peer Review Due: 12-05-2025 at 23:59

Final Report Due: 16-05-2025 at 23:59

Program Due Date: 26-05-2025 at 10:00

Total Marks: 145

# Contents

# 1    General Instructions

- *Read the entire assignment thoroughly before you start coding.*

- This assignment should be completed in teams of 2 or 3 students.

- **To prevent plagiarism, every submission will be inspected with the help of dedicated software.**

- Be ready to upload your assignment well before the deadline, as **no extension will be granted.**

- If your code does not compile, you will be awarded a mark of 0. The rendering output of your program will be primarily considered for marks, although internal structure may also be tested (eg. the presence/absence of certain functions or classes).

- Failure of your program to successfully exit will result in a mark of 0.

- Note that plagiarism is considered a very serious offence. Plagiarism will not be tolerated, and disciplinary action will be taken against offending students. Please refer to the University of Pretoria's plagiarism page at http://www.ais.up.ac.za/plagiarism/index.htm.

- You are allowed to use any standard of C++.

- The usage of ChatGPT and other AI-Related software is strictly forbidden and will be considered as plagiarism.

- No online-created objects and textures may be used. All objects and textures that you need to use must be created by yourself.

- You must use OpenGL version 3.3 for this practical.

# 2    Overview

During your study of computer graphics, you will encounter many different ways to achieve the same goal. In this assignment, you will need to use all of the knowledge obtained throughout the course to accomplish a realistic, real-time rendering of the IT Kiosk including lighting and shading.

The IT Kiosk can be found on the 3rd floor of the IT building and consists of a big open area capped with a semi-cylinder-like roof. The roof is semi-transparent, providing light to the seating area. This natural light is subsidised by LED spotlights that are mounted on the walls providing, additional light to the seated area.

For the floor plan, there are a number of seats, tables, and booths where students can sit and work or watch YouTube videos. There are also a series of artificial flowers in the IT Kiosk which aid in creating a relaxed ambiance for the venue.

Along the southern wall of the IT Kiosk, there are a series of "cutouts" where students can relax and work. Between each of the cutouts there is a hole where you can stare down into the informatorium below the kiosk. Here, students can spy on first-year students that are lost in the informatorium.

The southern and northern walls of the IT Kiosk extend another 2 floors above the IT Kiosk where the different offices of various departments can be found including computer science, information science, and informatics, etc. Since the walls are not flat, this effects how shadows form on them. The western wall is lined by a big glass sheet which separates the informatorium, offices and some of the computer science research labs from the Kiosk. On the eastern wall, two glass panels are separated by a wall which contains the elevator shaft for two of the elevators in the IT building.

To best showcase your rendering, you will create a "drone" that will be able to fly around the IT Kiosk. The drone contains a camera which will act as the camera view point for the rendering. You do not need to render any students or staff members in the IT Kiosk.

# 3 Your Task:

For this homework assignment, you will need to complete three tasks. The first task, described in Section 3.1, is to write a report where you will describe how you plan on rendering the IT Kiosk. The second task, described in Section 3.2 is to, as a group, peer review two other group's report and provide detailed constructive feedback. The last task, described in Section 3.3, is where you will implement the render of the IT Kiosk.

## 3.1 Report [45 marks]

As with practical 3, you need to plan how you will approach the rendering. This consists of a discussion on the following aspects:

### 3.1.1 North and South walls [5 marks]

In this discussion, you need to address how you will render the northern and southern walls of the IT Kiosk. What type of graphical data structure, if any, will you use to create the shape of the walls; how will you account for the windows and the offices behind the windows; what optimisation will you do to reduce the work load needed to render these walls, and so on.

### 3.1.2 East and West walls [5 marks]

This discussion follows the same structure as the discussion in Section 3.1.1 but this time, discussing the eastern and western walls of the IT Kiosk. Remember to focus on the glass panels and how the light will reflect off of them as well as how you will approach the scene behind the glass.

### 3.1.3   Roof [5 marks]

In this discussion, you need to focus on the roof. As stated previously, the roof of the IT Kiosk is a semi-cylinder-like structure created out of rib-like support structures and semi-transparent glass panels. You will need to address how you will attempt to render the curved shape of the of the roof and, if needed, provide an explanation on how the curved shape can be approximated for the sake of efficiency. Remember to focus on the graphical data structure that you will use, as well as how you will address the different colors of the different panels of the roof.

### 3.1.4   Floor plan [10 marks]

This discussion should form the bulk of your report, as you will need to address the layout of the IT Kiosk. You will need to address the different types of seating, tables and objects that can be found in the IT Kiosk. Together with your discussion, you will need to provide reference photos as well as basic designs that illustrates which shapes you will use to create the object. You will also need to provide a to-scale map of the floor plan that includes the dimensions of the IT Kiosk floor, as well as where each object will be placed. You will also need to provide an OpenGL rendition of the floor plan using one of the team members' practical 2.

### 3.1.5   Materials [5 marks]

In this section, you will discuss the different materials that can be found on the different surfaces in the IT Kiosk. You will need to provide a photo of each material that you discuss, as well as an explanation of how you will render the material and the color.

### 3.1.6   Lighting [5 marks]

Lighting forms an important aspect of the rendering. You will need to discuss the different light sources, the color of the light, the light reflections and the shadows created by the light sources. Remember, the sun's light that passes through the roof, also needs to be accounted for.

### 3.1.7   Code design [5 marks]

As this is still a computer science module, you need to discuss how you designed your code base. What type of traditional data structures, design patterns or code constructs did you use. Discuss why you used them. Also discuss which other data structures or design patters you considered but did not end up using.

### 3.1.8   Drone [5 marks]

The drone will act as a way to explore your rendering. You may use Practical 3 of one of your team members for the drone[1]. You will need to discuss how you will control the drone, if the drone will have any additional features such as lights or sensors; what type of projection you will use; if the drone will create a shadow., etc.

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[1]It can not be the same team member whose Practical 2 was used for the floor map.

### 3.1.9 Bonus marks

You need to discuss things that will be done for bonus marks and how you will approach them. Note only the things discussed in your report will count as bonus marks while marking your rendering.

## 3.2 Peer review [10 marks]

You will need to peer review two other teams' reports and give them detailed constructive feedback on their reports. Closer to the time, a marksheet will be released that you will need to complete and provide feedback on for the other teams. Once you receive the feedback from the other teams, your team can use the feedback to improve your own report before the final submission.

## 3.3 Rendering [60 marks]

After planning has been completed you need to render the actual IT Kiosk. You will be graded on intervals of 0%, 25%, 50%, 75%, and 100%. The bare minimum will grant you 60 marks and the remaining 30 marks will be comprised out of bonus marks. Note, for the LED lights you can approximate them as a single spotlight.

# 4 Bonus marks [30 marks]

There are 30 bonus marks available. Each bonus activity is worth 5 marks and can only be awarded once. Things that can be done for bonus marks are:

- Adding the wood siding on the walls.

- Adding a portion of the informatorium at each cutout.

- Adding extra details behind the glass on each wall such as offices.

- Changing the LED lights to be a set of smaller spotlights.

- Adding the coffee shop to the IT Kiosk, including snacks and a coffee machine.

- Adding 5 extra unique objects to the tables such as laptops, textbooks, coffee cups, bags, headphones or water bottles.

- Adding the ability to change the time of day, which is then reflected in the light created by the sun.

- Enabling the light to reflect off of the glass surfaces.

- Enabling the drone to have a night vision camera.

- Adding a flight information heads-up-display (HUD) to the drone camera which will show the current speed, altitude and orientation of the drone. the following URL can be used as an example of the expected HUD: `https://motionarray.imgix.net/preview-17495KUExmUZSeX_0011.jpg?w=660&q=60&fit=max&auto=format`.

- Zooming in on the camera of the drone. Note you will then need to somehow show that the drone remains stationary while zooming occurs.

- Adding different lights onto the drone that will interact with objects in the IT Kiosk.

- Adding a minimap to the drone camera that will indicate the drones current position in the IT Kiosk.

- Giving the drone collision detection with objects in the IT Kiosk.

- Adding different camera projections to the drone camera such as fisheye projections.

- Add a color filter to the camera of the drone, i.e. gray-scale, inverted or monochromatic.

- Being able to load a floor plan from a text file.

- ***If you have other ideas please make a post in the `homework assignment bonus features request` channel and the lecturer will approve or deny the bonus feature.***

# 5  Implementation Details

- You need to use OpenGL version 3.3 for this practical.

- You may use any of the build-in mathematical libraries within the `glm` package.

- You may use any of the built-in OpenGL functions to generate the shapes for you.

- You may use any of the built-in OpenGL functions to perform the transformations of the shapes.

- You may only use the following C++ and OpenGL libraries:

  - stdio.h
  - stdlib.h
  - iostream
  - iomanip
  - cmath
  - sstream
  - GL/glew.h
  - GLFW/glfw3.h
  - glm/glm.hpp

  You may also use the `shader.hpp` and `glad.c` files that assist with compiling and linking of shaders.

- All your helper classes and files needs to be in the same directory of the main.cpp.

- Ensure that the title of the window of your program is your correct student number.

- You may add additional code to the shaders to improve the efficiency of your rendering.

# 6     The use of Blender

Blender() can be used to model individual items in the

# 7     Submission

You are required to submit on ClickUp under the appropriate submission link.

For the report submit it as a pdf file.

For the render upload an archive. In the archive that you submit, include a makefile and compiling instructions such that the program can be compiled and executed by the markers if needed. *Failure to upload to ClickUP will result in you forfeiting all marks for this practical.* No exceptions will be made on this matter.

# 8     Demo Instructions

1. You will first be required to download your submission from ClickUP.

2. You will then demo your practical to the tutor.

3. In the presence of the tutor, you will be required to upload the archive you downloaded from ClickUP to FitchFork. *Failure to upload to FitchFork will result in you forfeiting all marks for this practical.* No exceptions will be made on this matter.

4. Exact demo instructions will be uploaded closer to the time.

# 9     Marking rubric

The following rubric will be used to mark your submitted assignment. The exact format of the demonstration will be discussed closer to the time. Please see Table 1 for the rubric.

| Assessment Criteria | Total marks | 0% | 25% | 50% | 75% | 100% |
|---|---|---|---|---|---|---|
| Drone [8 marks] | | | | | | |
| Drone movement | 4 | Drone is not able to move | | | | Drone is able to move in all directional three axis |
| Drone rotation | 4 | Drone is not able to rotate | | | | Drone can rotate about all three axis. |
| Objects [24 marks] | | | | | | |
| Number of objects | 4 | There are no objects in the IT Kiosk | | | | There are at least 15 objects in the IT Kiosk |
| Material of the objects | 8 | There are no objects in the IT Kiosk | | | | The rendered materials are an accurate approximation of the real material |
| Size of the objects | 4 | There are no objects in the IT Kiosk | | | | The rendered objects have an accurate size. |
| Shadows caused by lighting | 8 | There are no objects in the IT Kiosk | | | | The objects create an accurate shadow from the lights. |
| Walls [16 marks] | | | | | | |
| The shape of the northen wall | 4 | The wall is flat | | | | The wall has the same contours as the real life wall. |
| The shape of the southern wall | 4 | The wall is flat | | | | The wall has the same contours as the real life wall. |
| The shape of the eastern wall | 4 | The wall is flat | | | | The wall is comprised out of its three components correctly. |
| The shape of the western wall | 4 | The wall is flat | | | | The wall is comprised out of glass and shows the back offices. |
| Lighting [12 marks] | | | | | | |
| There are different light sources | 4 | There is none, or only ambient light sources | | | | There are two distinct types of light sources |
| The lights causes shadows | 8 | There is none, or only ambient light sources | | | | Each object creates a shadow for the correct light source |

Table 1: Marking rubric