CS4247
Graphics Rendering Techniques

Semester 2, 2020/2021

Assignment 4

Progressive Refinement Radiosity

School *of* Computing
National University *of* Singapore

Dates

- Release Date
  - 9 April 2021, Friday

- **Submission Deadline**
  - **23 April 2021, Friday, 11:59 PM**
    - Late submissions will NOT be accepted
    - The submission folder will automatically close at the deadline

Assignment Overview

- You are provided with an incomplete C/C++ program that implements the **progressive refinement radiosity algorithm**

- **Task 1**
  - Complete the program
  - Generate a radiosity solution for the sample input scene
- **Task 2**
  - Create a new input scene model
  - Generate a radiosity solution for the new scene

Learning Objectives

- Implementing the **Progressive Refinement Radiosity Algorithm**
- After completing the assignment, you should have learned
  - How to use the **Hemicube** algorithm to estimate **form factors**:
    - How to compute **delta form factor** for each pixel on the hemicube
    - How to set up OpenGL views to project the scene onto the faces of the hemicube
    - How to use the **item buffering** technique to identify the patch that occupies a pixel
  - How the progressive refinement radiosity algorithm works:
    - How to “shoot” light power from a **shooter patch** to the **gatherer patches**, and update the radiosity values of these patches
    - How to update the **unshot power** of a **shooter patch** with the new power received by its **child gatherer patches**
    - How to **terminate** the progressive refinement radiosity computation

What Are Provided (1) – For Windows

- Download the file **`cs4247_2021S2_assign4_todo_(win-vs2017).zip`** from the **`Assignments`** folder in LumiNUS Files
- The ZIP file contains a Visual Studio 2017 solution file **`assign4.sln`**. The solution has **three** C/C++ projects
  - QuadsViewer
  - RadiositySolver
  - RadiosityViewer
- **Tip:** In Visual Studio, to make a project the default project to be built and run, you can right-click on the project name in the **Solution Explorer**, and select "**Set as StartUp Project**"

What Are Provided (1) – For macOS

- Download the file **`cs4247_2021S2_assign4_todo_(mac-xcode).zip`** from the **`Assignments`** folder in LumiNUS Files
- The ZIP file contains the Xcode project **`assign4.xcodeproj`**, which has the following **three** C/C++ targets
  - QuadsViewer
  - RadiositySolver
  - RadiosityViewer

What Are Provided (2)

- **QuadsViewer** is a completed (old-style) OpenGL application that lets you preview the input scene model and check the subdivision of the input quads into smaller "**shooter**" quads and even-smaller "**gatherer**" quads
  - The default input scene model file is **`model.in`**
  - **Gatherer quads** are obtained by subdividing **shooter quads**
  - Press "m" to cycle through display of the input quads, the shooter quads, and the gatherer quads
  - In **`quadsviewer.cpp`**, the size of the shooter and gatherer quads are controlled by the values of **`maxShooterQuadEdgeLength`** and **`maxGathererQuadEdgeLength`** respectively
    - These two values are from the input scene model file **`model.in`**
    - **`radiositysolver.cpp`** also uses these two values for the same purpose

What Are Provided (3)

- **RadiositySolver** is the <u>incomplete</u> program that
  - Reads the input scene model from **`model.in`**
  - Subdivides the input quads into “shooter” and “gatherer” quads
    - In **`radiositysolver.cpp`**, the size of the shooter and gatherer quads are controlled by the values of **`maxShooterQuadEdgeLength`** and **`maxGathererQuadEdgeLength`** respectively
      - These two values are from the input scene model file **`model.in`**
  - **Computes a radiosity solution for the scene**
    - **This step is the part to be completed**
  - Computes vertex radiosities from the patch radiosities
    - This step can take very long to run, so you should first test your radiosity algorithm implementation with a model with not too many gatherer quads
  - Outputs the model with radiosity solution to the file **`model.out`**

What Are Provided (4)

- **RadiosityViewer** is a completed (old-style) OpenGL application that lets you view the model output by **RadiositySolver**
  - Reads in a model with radiosity solution from file **`model.out`**
  - Performs simple tonemapping to map radiosity values to displayable color values (i.e. to R, G, B values from 0.0 to 1.0)
  - Renders the polygons using the tonemapped radiosity values as vertex colors
  - You can try the viewer on the given sample model file **`cornell_box.out`**
    - First, copy **`cornell_box.out`** to the file **`model.out`**
    - Note that the sample **`cornell_box.out`** has been "watermarked" with some bright and dark patches — your radiosity solution for **`cornell_box.in`** should not have those

Task 1

- Complete only the source file **`radiositysolver.cpp`**, which is part of the **RadiositySolver** project
  - Complete the code at places marked "**`WRITE YOUR CODE HERE`**"
  - You can add additional functions to the file
  - Use good coding style and document your code adequately (otherwise marks deducted)
  - Study the files **`quadmodel.{h,cpp}`** to see how the scene model and its subdivided quads are represented
  - You can make use of helper functions found in **`common.h`** and **`vector3.h`**

Task 1 (continue)

- Test your program on the provided sample input scene model **`cornell_box.in`**
  - **Before** running your RadiositySolver, copy **`cornell_box.in`** to the file **`model.in`**
  - **After** running your RadiositySolver, copy the output file **`model.out`** to **`cornell_box_my.out`**
- View your radiosity solution **`model.out`** using **RadiosityViewer** (in non-wireframe mode) and capture <u>three different snapshots</u>
  - On Windows 10, you can use the **Snip & Sketch** tool (press Win + Shift + "S") to take a snapshot of the window and save the image
  - Use the default window size
  - Save the **three** snapshots to image files
    - **`cornell_box_1.png`**
    - **`cornell_box_2.png`**
    - **`cornell_box_3.png`**

Task 1 — RadiositySolver Explained

- **RadiositySolver** uses to the Progressive Refinement Radiosity algorithm to compute patch radiosity of each gatherer quad
  - Pre-compute the **delta form factors** on the **top face** (already done) and **side faces** of the hemicube
    - Note that top hemicube face has same pixel resolution as the default window size (always a square)
  - Progressive Refinement Radiosity loop
    - Find the **shooter quad** with the **greatest unshot power**
    - Use a **hemicube** to compute **form factors** from the shooter quad to each of the gatherer quads
    - Update the **radiosity** of each of the gatherer quads
    - Update the **unshot power** of each shooter patch with the new power received by its child gatherer patches
    - **Terminate loop** if max iterations is reached

Task 2

- Create a new scene model
  - Study the sample scene model **`cornell_box.in`** to find out the input model file format
  - Name your new scene **`new_model.in`**
  - Run your **RadiositySolver** program on **`new_model.in`** to output **`new_model.out`**
  - View **`new_model.out`** in **RadiosityViewer** and capture <u>three different snapshots</u>
    - Use the default window size
    - Save your snapshots to image files
      - **`new_model_1.png`**
      - **`new_model_2.png`**
      - **`new_model_3.png`**

What to Submit

- Only the following **10** files
  - Task 1
    - `radiositysolver.cpp`
    - `cornell_box_my.out`
    - `cornell_box_1.png`, `cornell_box_2.png`, `cornell_box_3.png`
  - Task 2
    - `new_model.in`
    - `new_model.out`
    - `new_model_1.png`, `new_model_2.png`, `new_model_3.png`

How to Submit

- Put only the required files in a single ZIP file

- Name your ZIP file ***your-student-number*`_assign4.zip`**
  - e.g. **`A0123456X_assign4.zip`**

- Submit your ZIP file to the **Assignment 4 Submission** folder in LumiNUS Files
  - Folder will close at the deadline
  - You may upload your ZIP file multiple times, but we take the latest
    - Please delete your older versions

Other Requirements

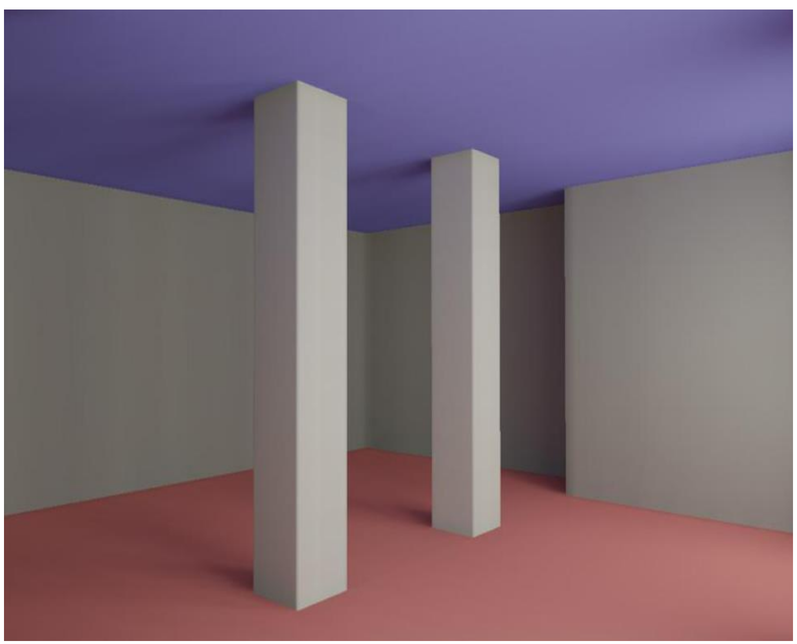
- Programming languages and APIs
  - C / C++
  - OpenGL 1.1 (old-style OpenGL; no shader)
  - GLU & GLUT / FreeGLUT
  - No other third-party APIs are allowed

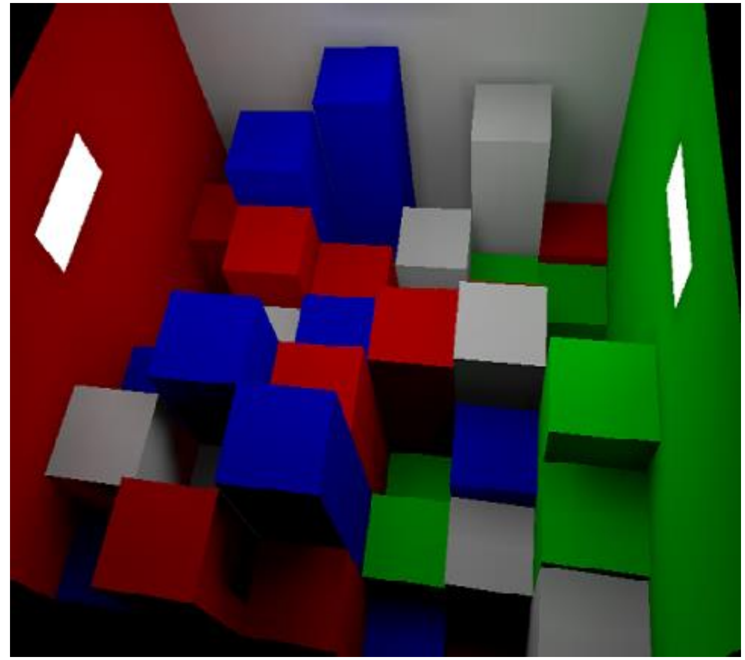
- Platform
  - You can develop your program on any OS and IDE
  - However, the final submitted version must be compilable/buildable in Microsoft Visual Studio 2017

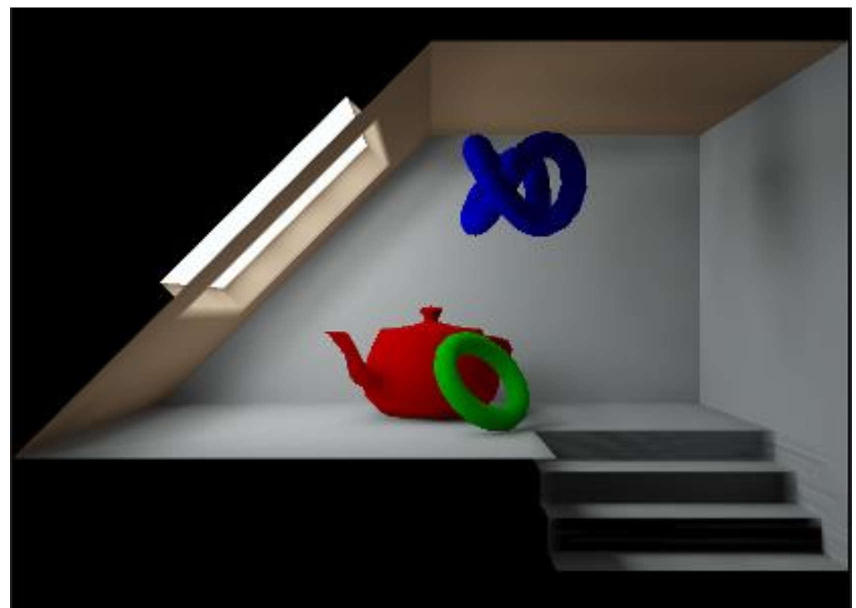
Grading

- Maximum marks is **100**
- Constitutes **9%** of total marks for CS4247
- Marks allocation
  - **Task 1 – 80 marks**
    - Correctness & Coding Style
  - **Task 2 – 20 marks**
    - Task completion (10 marks)
    - Aesthetics and complexity (10 marks)

Past Submissions for Task 2







The End