CS432 GPU Accelerated Computing
Assignment 3

CS Program
Habib University

Spring 2024
Due Date: 5 April 2024 @ 11:59PM

1 Introduction

There are two questions in this assignment. You should attempt one of the two questions. Each question carries 50 marks.

2 Question 1 - Easy

Create a list of 100000 random integer numbers.

1. Share the amount of time it takes to populate data in the array on the CPU. Use any timing function like clock() or hiresolution counters to note the amount of time it takes to generate data on the CPU. (+20)
2. Find a way to do the random data initialization of the array on the GPU using the Thrust API. Note the time it takes to run the kernel using the CUDA event API to calculate the amount of time needed by the GPU. (+20)
3. Write a report on the performance of the GPU code for different data sizes: 10000, 100000, 1000000 random integer elements. Note the amount of time it takes to sort the data on the GPU using Thrust and on the CPU. (+5)
4. Documente the code with comments and complete error handling of the CUDA functions. (+5)

3 Question 2 - Pathtracer

Smallpt is a simple path tracer build in 99 lines of C++ code. Details about it are given in the presentation by David Cline [1] which is shared on LMS with this assignment. In this assignment, you will convert smallPT into CUDA to generate outputs of the following scenes.

3.1 Scenes

1. The Cornell Box scene as given in smallpt modeled using Spheres [2]. See Fig. 1.
2. Richie Sams scene of plane and 9 balls given in [3]. See Fig. 2.
3. Wikipedia scene of one light source with red sphere on the left and green sphere on the right as given on wikipedia page [4]. See Fig. 3.

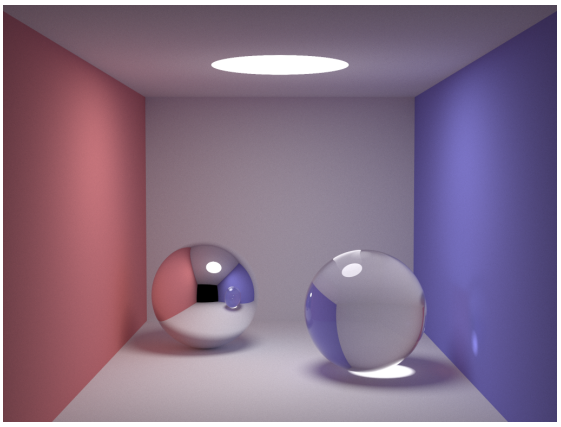

Figure 1: The Cornell Box scene rendered using smallpt.

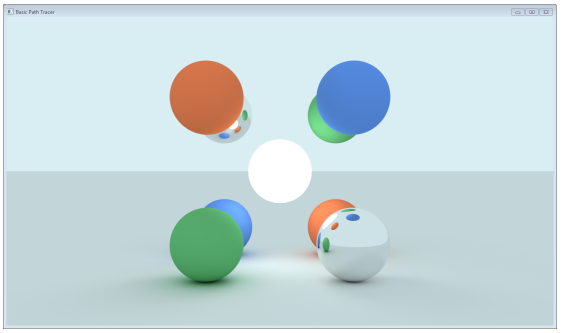

Figure 2: Nine ball scene by Richie Sams.

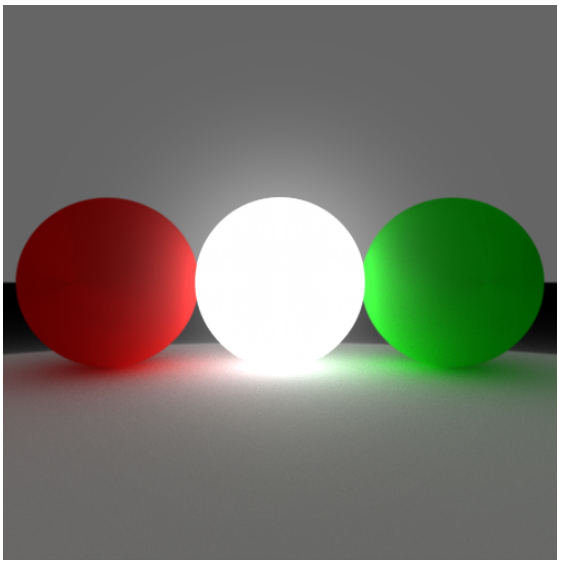

Figure 3: The three spheres scene from wikipedia.

3.2 Tasks

1. CPU implementation of smallpt in Google colab environment compiles and works fine. (+5)
2. GPU implementation of smallpt in Google colab environment compiles and works fine. (+10)
3. Three BRDf types: diffuse, specular and transparent provided and work correctly. (+15)
4. Report detailing the design of your GPU smallpt and the comparison of performance of CPU code vs the GPU code. (+15)
5. Error handling in your code so any CUDA error should be reported to the user. (+5)

4 Deliverables

Submit a colab notebook (.ipynb) file with your regn. no. as the filename i.e. [$ABxxxx\_Assgn1$].ipynb. It should contain your solutions for Questions 1 or 2 and the required work like graphs presented in a report form. Use the jupyter notebook text and code cells and write a consolidated report. **No other file name or file type will be accepted.** You might be called for a viva in case there is a need.

5 Deductions Note

Failing to comply to the instructions will result in a deduction of 20 percent score. Late submission policy as per syllabus will be applicable.

6 Using chatGPT or other AI software

You are not allowed to use any AI software to obtain the code for this assignment. Appropriate tool will be used to evaluate your submission for AI tool usage. If you are found using such a tool, you will be given a straight 0 and an Academic Conduct will be filed against you for academic dishonesty. If you are seeking help from any online resource please given an attribution in the references section. Failure to do so will be considered plagiarism.

7 Plagiarism Policy

We have zero tolerance for plagiarism. The assignment submission should be your own genuine work without copying content from anyone else in the class or from the internet. If there is any evidence of plagiarsim, the case will be reported.

References

[1] David Cline, *smallpt presentation*, available online: `https://drive.google.com/file/d/0B8g97JkuSSBwUENiWTJXeGtTOHFmSm51UC01YWtCZw/view`. (Accessed on 21 March 2024).

[2] Kevin Beason, *smallpt: Global Illumination in 99 lines of C++*, available online: `https://www.kevinbeason.com/smallpt/`. (Accessed on 21 March 2024).

[3] Richie Sams, *RichieSam's Adventures in Code-ville* github repo: `https://github.com/RichieSams/rapt` available online: `https://richiesams.blogspot.com/2015/04/making-our-first-pretty-picture.html`. (Accessed on 21 March 2024).

[4] Wikipedia three spheres scene: available online: `https://fr.wikipedia.org/wiki/Path_tracing#/media/Fichier:Pathtrace3.png`. (Accessed on 21 March 2024).