GPU Computing: Freestyle Assignment

Max-Gerd Retzlaff * Emanuel Schrade † Tamás Szép ‡

Abstract

The first four tasks introduced the basics of GPU architectures, parallel programming primitives, image filtering and physical simulation. In this final assignment you can demonstrate your parallel programming skills on a completely custom application. This problem can be different from the topics covered in the previous assignments, but you are also free to build upon your existing solutions (provided that you add enough of new complexity to the problem).

Deadlines/Timeline:

01.06.2016	Call for Proposals
08.06.2016	Topic mail deadline
11.06.2016	Topic finalization
15.06.2016	Draft proposals
22.06.2016	Final proposals
16.07.2016	Assignment upload deadline
20.07.2016	Presentation and evaluation

1 Overview

The goal of this assignment is the creative solution of a custom problem, using the previously demonstrated GPU programming techniques. For this reason, the assignment is organized in a different way than the previous ones. Instead of a strict and exact specification for implementation and evaluation, we only provide general guidelines for this exercise, and we leave the entire concept to your choice. The number of problems that can be efficiently parallelized is vast, and thanks to the completion of the preceding problems you already have a basic tool-kit for OpenCL programs in your field of interest.

The assignment consists of four main steps:

1. Topic selection
2. Initial concept
3. OpenCL implementation
4. Presentation and Evaluation

2 Topic

We first ask you to decide upon a topic and send us an email naming your topic and a short description of what you propose to do. This helps us to avoid topic collisions early on. Each participant will be assigned a supervisor for his topic after the topic has been selected. If there are topic collisions we will ask that you chose a new topic. Topics will be assigned on a first-come, first-served basis.

Please send your topic suggestions to the main contact for this course. You will then be assigned a supervisor and all further communication regarding the proposal should directed directly to your supervisor.

*retzlaff@kit.edu
†schrade@kit.edu
‡tamas.szep@kit.edu

3 Concept

After you agreed with us on a selected topic, the specification needs to provide a more detailed definition and propose scores. As a first step, you will need to write a short specification (about one page length). The specification should define the problem and how it can be solved on massively parallel hardware. If you are going to extend a previous assignment, you should clarify the improvements compared to the existing solution.

We expect you to do some preliminary research on your chosen topic for this concept, so please include any references you plan to use in your concept.

You will need to get your plans accepted before you start the implementation itself. We will accept your specification if it has similar complexity to the previous assignments, and the definition of the problem is clear enough. Every concept should be unique, but we strongly encourage you to use some of the parallel programming primitives you learned during this course.

The main sections of the concept should be

1. **Introduction** Short description of the chosen problem. Motivations and goals of your project.
2. **Implementation** Discuss what parts of the problem have a parallel nature, and outline how do you plan to implement it in OpenCL. For example, which parallel programming primitives can be used.
3. **Evaluation and Results** It is always important to specify what are the expected results of the project. For instance, when introducing an **optimization** of a naive algorithm, you would expect a certain amount of speed-up in advance. It is also important to examine the **scalability** of the application. Does the performance scale linearly with the number of computational units? If not, why? The specification is complete if it also contains ideas about evaluating the results.

Send a draft proposal to your assigned supervisor until the deadline stated at the beginning of this document. Do not send the draft proposal at the last possible minute because your supervisor will need some time to review the proposal and get back to you with suggestion and/or requests to be included in the final proposal which is due a week after the draft proposal.

4 Implementation

You will have a bit more than three weeks to implement your project until the upload deadline. We ask you to hand in your assignment through our submit system. It must be in a buildable state. Please include any necessary build instructions in your submission. Your are not required to use the framework from the startup kits, however, you are welcome to do so. As before you can freely choose your operation system.

5 Presentation and Evaluation

There will be no evaluation in the ATIS pool, instead you must prepare a short presentation (about 8-10 minutes) to introduce your assignment and the solution to the other members of the course. As each implementation will be fundamentally different, it is beneficial

to share your results and discuss your problems with the others. The presentation itself is only a brief summary followed by a short discussion. The structure of the presentation should roughly follow the concept, but extended with demo(s) and results of your running application (a capable OpenCL GPU will be provided in the system used for the presentation). The presentation should conclude with performance measurements, similarly to the recent assignments.

Akin to the former assignments, you can receive 20 points in total, in the following parts:

- 2 points: initial concept
- 14 points: implementation in OpenCL
- 2 points: short presentation
- 2 points: evaluation and discussion (Q & A)

The distribution of the 14 points will fit to your custom problem. This time you can propose a scoring table for your assignment as well, as part of the initial concept. Using the previous assignments as guidelines, you should break down your implementation into smaller steps and assign points for each step. We will use this scoring table during the evaluation, so this assignment is the most flexible one. However, we will correct unrealistic scoring tables before we accept the specifications.

6 Examples

We want to stress that you are not limited by these examples in any way. However, to get you started, we give you a few examples of what might be suitable freestyle topics:

- Extend the particle system with efficient inter-particle collisions.
- Extend the cloth simulation with cloth self-collision test.
- Fluid simulation
- Efficient parallel sorting
- Path-finding
- Image processing algorithms, e.g. optical flow, distance transformation
- Rendering techniques like ray tracing or volume rendering using ray marching
- ...