EEP 590 C/D
GPU-Accelerated Computing + Visualization

Spring 2023 – Course Outline and Schedule

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University of Washington – Electrical and Computer Engineering
Professional Masters Program
Spring 2023

Main Course Topics

- **CUDA-GL Interop** : CUDA – OpenGL Interoperability API
  - How to use both OpenGL and CUDA and exchange data/memory without making host-device round trips. This will involve learning some more advanced CUDA and OpenGL API techniques:
  - Advanced CUDA Concepts
    - CUDA streams and events
    - CUDA Surface objects
  - Advanced OpenGL Concepts
    - Off-screen rendering
    - Compute and mesh shaders
- NVIDIA Turing GPU HW Architecture – CUDA/OpenGL API mapping
- Understanding & Programming **RT Cores** (NVIDIA ray tracing hardware)
  - Bounding-volume hierarchy (BVH) acceleration data structures
  - Ray-triangle intersection
  - GLSL extensions for HW ray-tracing
- Understanding & Programming **Tensor Cores** (NVIDIA dedicated GEMM HW)
  - CUDA Warp matrix API

Main Course Topics

- Parallel computational performance theory and metrics
- Profiling and analysis of GPU performance and tuning/optimization
  - Inspect and analyze dedicated GPU hardware counters
  - Understand interplay of device memory hierarchy, SM warp scheduling, and other factors determining algorithm(s) performance
- We will spend a significant amount of time reviewing code and applying analysis techniques for several application case studies which illustrate interactive GPU parallel execution with CUDA-GL interop for interactive visualization
- In-depth Case Studies
  - 3D thermal heat transfer solver and visualizer
  - 3D Point Cloud surface reconstruction and visualization
  - Fused biomedical imagery reconstruction and visualization

Course Schedule

- All online/remote class - *no in-person classroom meetings*!
- Schedule (subject to changes as quarter evolves)
  - Class meets live online on MONDAYS from 6-8 on Zoom
  - Additional weekly recorded lecture content will be posted using Panopto

L#	Date	Topics
1	3.27.23	Review of CUDA and OpenGL fundamentals
2	4.3.23	CUDA-OpenGL Interop preliminaries
3	4.10.23	CUDA-OpenGL Interop
4	4.17.23	Introduction to NVIDIA tensor cores
5	4.24.23	Introduction to NVIDIA RT cores
6	5.1.23	NVIDIA Nsight Systems/Compute/Graphics Profiling
7	5.8.23	Detailed Case Studies…
8	5.15.23	Detailed Case Studies…
9	5.22.23	Detailed Case Studies…
10	**5.29.23**	Detailed Case Studies and Course Conclusion
	6.8.23	Final Project Final Report DUE

***Green** lecture date above (10) is a federal/UW holiday - recorded lectures will be provided

Course Logistics

Course Overview:

- There will be 10 lectures delivered via online Zoom (except for 1 holiday re-recorded video)
- *Official Schedule***: Live Zoom lectures are **Monday evenings 6-830 PM (pacific time, PST)**
- Hands-on programming exercises will be part of the weekly curriculum.
- There will be 4 homework assignments which will consist of (a) readings, (b) theory, (c) coding.
- The remainder of the quarter will be focused on a final project which will be comprised of a fairly significant GPU code design and implementation utilizing and applying techniques learned in the class.
  - **Project Parts**: Project Proposal (10%), Design specification (35%), Final report and results (55%).

Grading:

- Homework (4) *55% (10/15/15/15 pts)*
- Final Project *45% (see project parts breakdown above)*

Course Policies

Collaboration and discussion of homework assignments and project design and implementation with your fellow classmates, professor, TA and others is highly encouraged! However, the work you submit must be your own, and you must write your own code(s). *Copying code and plagiarizing is not allowed*.