Project Proposal: Researching GPU architecture

Alexander Hoppe, Taylor Sheneman, William Derksen, Sam Myers

Description

In this project, we would like to do in-depth research on a number of common/interesting GPU architectures, comparing their strengths and weaknesses and developing an understanding of both the constraints of this type of processor and the design tradeoffs made in the chosen architectures. We'd like to study an older model of GPU (provided it checks out) and understand the design decisions they made there. In the spirit of parallelism, we're going to divide and conquer, with one subteam studying the design details of a "unified shader core", a single modern GPU unit. The other subteam will tackle a more high-level report on the GPU processing pipeline and the thread execution controller.

References:

http://www.ijmer.com/papers/vol%201%20issue%202/Q012358363.pdf

- Somewhat helpful paper on the reason GPU's exist and a bit about how they work.

http://www.haifux.org/lectures/267/Introduction-to-GPUs.pdf'

- Significantly helpful Slidedeck explaining the general layout of the different blocks of a GPU, and how they connect / why.

http://developer.amd.com/wordpress/media/2012/10/R700-Family_Instruction_Set_Architecture.pdf

- **SUPER USEFUL GUIDE** on the ATI R-700 instruction set architecture for the AMD GPU

https://stackoverflow.com/questions/1697842/do-graphic-cards-have-instruction-sets-of-their-own/1697883#1697883

- Stack overflow post with numerous links to different instruction set architectures for Graphics Processing Units.

http://catlikecoding.com/unity/tutorials/rendering/part-1/

- Shader Code Tutorials

Goals:

Minimum:

- Research general GPU architecture and decisions
- Block diagram a GPU showing all important functional units
- Answer the question: Why is a GPU worth having?

Planned:

- Detailed explanation of the vector shader and fragment shader pipeline
- Heuristic explanation of thread execution controller
- Block diagram of specific core architecture for GPU (probably AMD R700)
- Schematics of unified shader core
- In-depth research on a specific GPU microarchitecture (older, public domain)
    - Analyse design decisions, propose improvements if possible

Stretch:

- Implement unified shader core
- Hardware level schematics of thread execution controller

Explicit Deliverables:

- Explanation for Thread control of multiple shader cores / work distribution
- Deep dive in understanding and creating a unified shader core, with a block diagram as a deliverable.

Work Plan:

Step	**Date**	**Hours**
Proposal	Monday, 11/27	1.5
Research (overview of architectures, what makes a GPU a GPU, ISAs at a high level)	Wednesday 11/29	2
Research (find an older model of GPU we can poke around in)	Thursday 11/30	1
Research (more in-depth, on 2 or 3 more modern architectures, compare with older architecture)	Friday, 12/1	2
High level block diagram	Saturday, 12/1	2
Compare and contrast GPU design decisions	Weekend 12/2-12/3	1.5
Is it feasible to extend the ISA to include GPU instructions?	Weekend 12/2-12/3	.5
Feasible to simulate an external GPU to our existing CPU?	Weekend 12/2-12/3	.5
Make flowchart/heuristic model of work flow controller	Weekend 12/2-12/3	1

Midpoint check-in	Tuesday, 12/5	.5
Write research section of deliverable	Thursday 12/7	3
Implement a very RISC unified shader unit	Weekend 12/9-12/10	6
Finish deliverable website	Weekend 12/9-12/10	3