EE 4702-1, GPU Programming

When / Where

• Here (3129 P. Taylor Hall), MWF 9:40-10:30 Fall 2009
• http://www.ece.lsu.edu/koppel/gpup/

Offered By David M. Koppelman

• Room 349 EE Building
• Office Hours: Monday-Friday 14:00-15:00

Prerequisites by topic: C++, physics, calculus.
GPU Definition

**GPU:** Graphics Processing Unit

- Does 3D graphics and other computation in place CPU...
  ... because it's much better at it.
- Also used for *accelerating* scientific computation.

GPU is main component of video cards.

**Major Companies and Brands**

- NVIDIA
- ATI (Compaq)
This Course

Focus is on GPU programming

- Shader programming with OGSL.
- GPGPU programming with CUDA.

Also cover some 3D graphics, game physics.

- Will cover enough graphics and OpenGL to do cool stuff.

Course will include a game physics term project
AVATAR

LSU AVATAR

- **AVATAR**: Arts, Visualization, Advanced Technologies and Research
- [http://www.avatar.lsu.edu](http://www.avatar.lsu.edu)
- AVATAR includes several initiatives in the area of digital media.
- Includes research and instructional components.
- First product will be a minor in Digital Media...
  ...expected to be ready for Spring semester.
- This course, and others, will count toward that minor.
Balloon Demo

Simulation of a balloon.

GPU always does 3D graphics.

Code can switch between CPU-only and CPU/GPU physics.

Term project can be an extension of this code.
System Overview: Hardware

Typical Hardware

- On Computer motherboard: CPU, CPU Memory
- On Video Card GPU, GPU Memory
- Connection between CPU/GPU via Bus, e.g., PCI Express (PCIe).
- Connection from video card to monitor.
System Overview: Frame Buffer

**Frame Buffer**

- Area of memory continuously converted to a video signal.
- Simple mapping from memory address to pixel coordinate.

**Older Systems**

- Frame buffer in CPU memory.
- Application programs wrote frame buffer directly.

**Typical Current Systems**

- Frame buffer in GPU memory.
- Frame buffer written by GPU hardware (typical)...
  ... at end of long chain of events initiated by application.
System Overview: Frame Buffer

Frame Buffer Contents

- Position in FB corresponds to particular pixel on display.
- In illustration, first FB element is upper-left pixel.
- A common FB element size is 32 bits.
- Frame buffer format varies with video mode and of course system.
System Overview: Software

Just For Today, Oversimplify to Two Kinds of Software

• Application Program (Ap for short)
  – Written by app. programmer.
  – E.g., Balloon Demo
  – Most of Ap runs on CPU.
  – Part of Ap may also run on GPU.

• GPU Driver (Driver or Dr for short)
  – Written by GPU manufacturer.
  – E.g., NVIDIA 185.18.14
  – Driver code runs on both CPU and GPU.
  – Most work done by driver code that runs on GPU.
System Overview: Running of Application

Typical Execution

• Application, running on CPU, ready to emit next frame.
• App. calls driver on CPU...
  ...driver on CPU starts more driver code on GPU...
  ...application resumes on CPU (while GPU driver code still running).
• Process above repeated many times for a frame.
• Driver code ultimately will write frame buffer.

Important Points

• CPU and GPU can run code at same time.
Example Below

- Ap calls driver three times.
- First two times, driver does all work, mostly on GPU.
- Third time that ap calls driver, driver starts some ap code on GPU.
Course Coverage

Cover everything to write dynamic simulation.

Topics

- Rudiments of Animation by Dynamic Simulation
- Term Project
- Mathematics
- 3D Graphics: Primitives, colors, textures.
- Data movement and staging, efficiency.
- Coding with GPU shader model, CPU/GPU load balancing.
- Coding with CUDA, GPU physics.
- GPU Algorithms