

Interactive Geometric & Scientific Computations using Graphics Hardware



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Course WWW Site



http://gamma.cs.unc.edu/SIG03_COURSE/

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Graphics Hardware



- Designed to generate pretty pictures
 - Drawing and filling primitives
 - Geometric transformations
 - Texturing

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Graphics Hardware: Primary Application



- Fast Rendering of primitives (triangles)
 - Lighted
 - Smooth shaded
 - Depth buffered
 - Textured mapped
 - Anti-aliased

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Graphics Hardware: Recent Features

- Multi-texturing
- Pixel textures
- Programmable shading & support
- Programmable vertex engines
- Floating-point fragment pipelines & frame buffers

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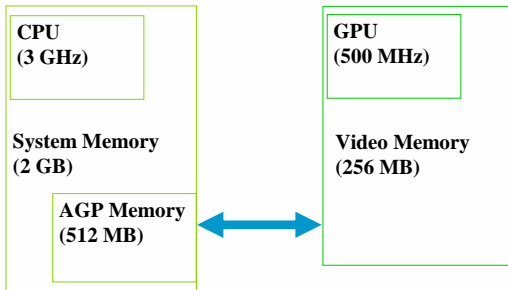
Graphics Hardware: Recent Trends

- Performance has been growing well above Moore's law
- It is becoming more programmable

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Current PC Graphics

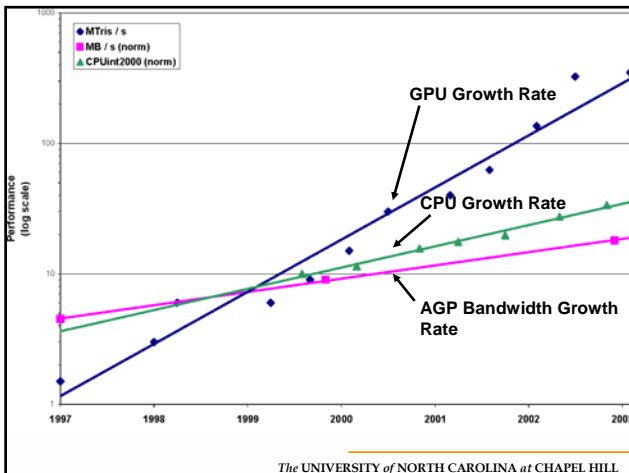
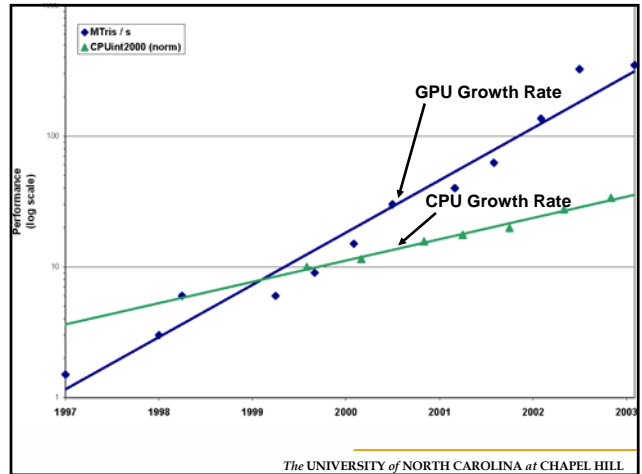
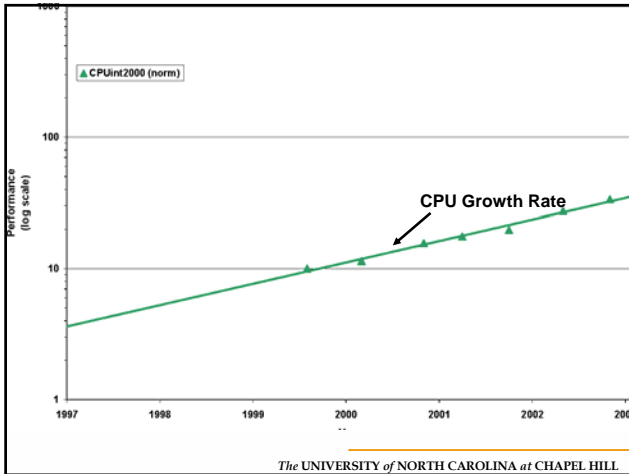


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CPU, GPU and Bandwidth Growth on Consumer PCs

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Graphics Hardware: New Applications

- Can we do something else besides:
 - Drawing pretty pictures
 - Trying to render 20 million triangles per second
 - Play the newer version of Quake

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Graphics Hardware: New Applications

- **Can we do something else besides:**
 - Drawing pretty pictures
 - Rendering 1 billion triangles per second
 - Play a newer version of Quake
- **Can it be used as:**
 - Useful co-processor for diverse applications
 - Efficient processor of images

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Graphics Hardware: Features

- **Rich in computational units**
 - Lots of highly pipelined units
 - Efficient streaming model of computation
 - Memory accesses pipelined to hide latency
- **Very high memory bandwidth**
 - Multiple gigabytes / second memory bandwidth
- **Co-processor to CPU**
 - Graphics processors runs in parallel to CPU

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Goals of the Course

- Exploit graphics processor as a co-processor for geometric & scientific applications
- Issues in programming graphics pipeline
- Novel applications

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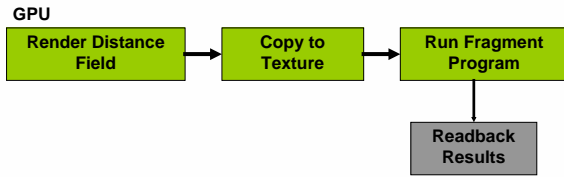
Recent Trends

- Session on "**Computation on GPUs**" on Thursday at SIGGRAPH
- Major trend at the ACM/Eurographics Workshop on Graphics Hardware & other conferences

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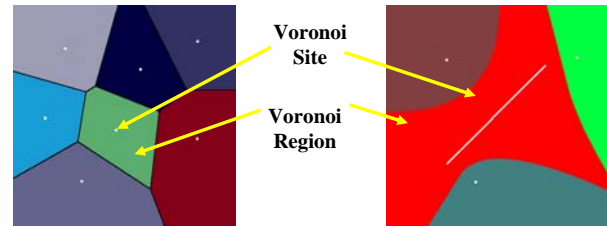
GPU Based Computations



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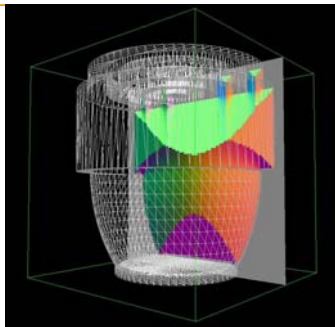
Voronoi Computations



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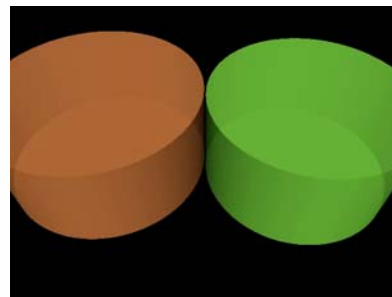
Distance Fields



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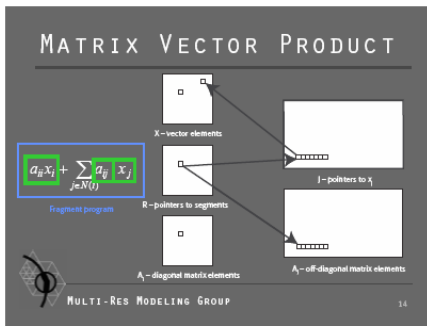
Collision Detection



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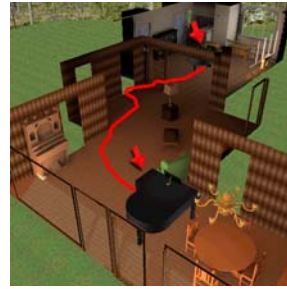
Scientific Computations



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Motion Planning



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Ray Tracing on GPUs

Soda Hall Outside			Soda Hall Inside			Forest Top Down			Forest Inside			Bunny Ray Cast		
v	r	z	v	r	z	v	r	z	v	r	z	v	r	z
14.41	2.52	0.44	26.11	40.46	1.00	81.29	34.07	0.96	130.7	47.90	0.97	93.93	13.88	0.82

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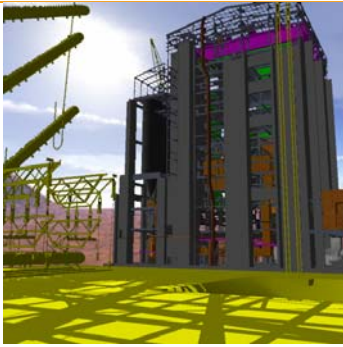
Interactive Walkthroughs



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Interactive Shadows



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Benefits of Graphics Hardware

- Efficiency
- Ease of implementation
- Interactive performance
- Robustness: fewer degeneracies

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Course Overview

- Overview of graphics hardware
- Programming graphics hardware
- Geometric & scientific applications

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GPU is a very useful co-processor

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Overview of GPUs

- Overview of Graphics Hardware: **Spitzer**
- Programmability Features of Graphics Hardware: **Doggett**

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Geometric & Scientific Applications

- Streaming Geometric Computations on the GPU: **Krishnan**
- Discretized Geometric Computations on the GPU: **Manocha**
- Scientific Computations using GPUs: **Schröder**
- Computer Vision on GPUs- **Pollefeys**
- Physically-Based Modeling & Interactive Navigation using GPUs – **Lin**
- Implementing a GPU Efficient Fast Fourier Transform- **Spitzer**
- Ray Tracing and Global Illumination using Graphics Hardware – **Purcell**
- Interactive Walkthroughs using Multiple GPUs - **Manocha**

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- Thank you for attending
- Questions, feedback, comments?

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