ECE4893A/CS4803MPG: Multicore and GPU Programming for Video Games

Introduction

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Games are “serious business” (1)

- Facts from www.esa.org:
  - $7.4 billion revenues in 2006
  - Average player is 33 years old and has been playing for 12 years
  - 36% percent of American parents play computer
  - 80% percent of gamer parents play with their kids
- From Blizzard press release:

  World of Warcraft surpasses 10 million subscribers in January 2008
  - $13 to $15 monthly (for 2.5 million in U.S. at least)
  - **Do the math!!!**

Screenshot from www.worldofwarcraft.com/burningcrusade/imageviewer.html?,images/screenshots/,65,241,

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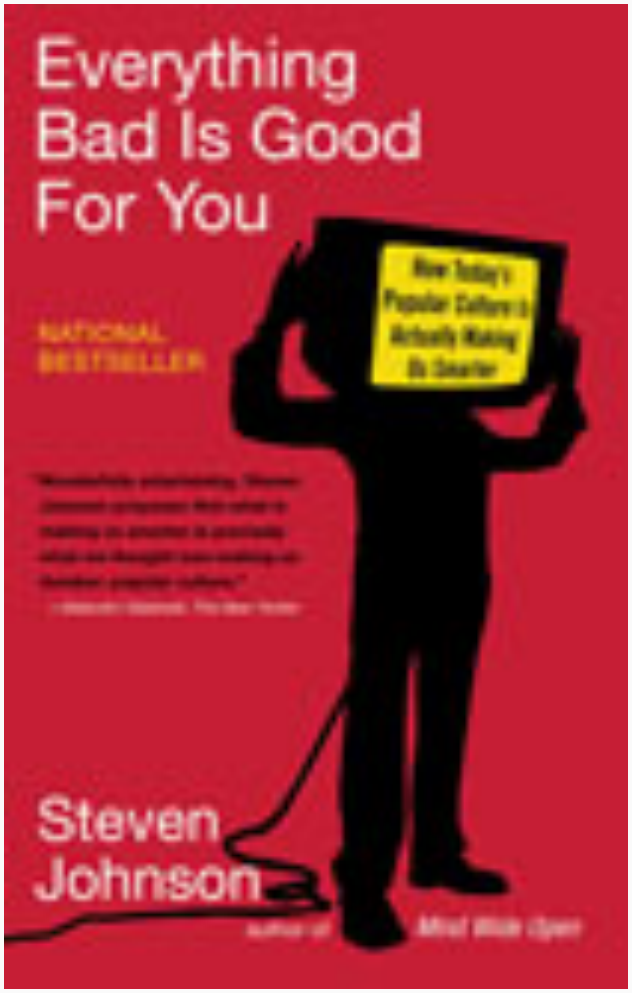
Games are “serious business” (2)

Stephen Johnson, “Everything Bad is Good for You: How Today's Popular Culture Is Actually Making Us Smarter”



Screenshot from
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Our MPG class fills an industry need (1)

"CPU/GPU programming skill is the biggest hole they have. They can't find students who can do it well."

- Prof. Blair MacIntyre

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Our MPG class fills an industry need (2)

"The biggest challenge facing game companies right now is the problem of writing multithreaded code that fully supports the multiple-core architectures of the latest PCs and the next generation game consoles."

- Jeremy Reimer,
"Valve goes multicore"

http://arstechnica.com/articles/paedia/cpu/valve-multicore.ars

Picture from Wikipedia

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Our MPG class fills an industry need (3)

"If a programming genius like John Carmack can be so befuddled by mysterious issues coming from multithreaded programming, what chance do mere mortals have?"

- Jeremy Reimer, "Cross-platform game development and the next generation of consoles"

From www.eurogamer.net/articles/i_johncarmack_doomrpg

http://arstechnica.com/articles/paedia/hardware/crossplatform.ars

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The realities of real-time

- The architectures we will look at are driven by real-time constraints
  - 60 frames per second
  - 1/60 ≈ 16.7 milliseconds
  - Average performance is irrelevant; **it's the minimum that matters**
- In contrast, most scientific applications can be handled "offline"
  - Computers historically designed to work well in "batch mode"

NOT a course on game design, or…

- See CS4455: Video Game Design
  - Founded by Amy Bruckman in 1998
- See CS4731: Game AI for the real deal on AI
  - But we may dabble in AI just a little bit
- Also won't be talking about…
  - Handheld game devices
    - That may change in the future!
  - "Alternative" controllers
  - Networking issues (LAN parties, MMORPGs, etc.)
  - Prototyping, user testing
  - Societal impact of games
  - Gender and games
  - Business issues (organizational issues of large teams, etc.)
- May incidentally touch upon some of the above issues

Only partially a graphics course (1)

- No background in computer graphics required!
  - Make sure class is accessible to ECE majors
- We will review a minimal amount of necessary background
  - Geometric transformations, backface culling, clipping, rasterization, lighting, texture mapping, etc.
- Emphasis will be on real-time graphics

Only partially a graphics course (2)

- We won't be talking about things like…
  - Perception
  - Global illumination: ray tracing, radiosity, photon mapping
    - Although people are putting such algorithms on GPUs!
  - Advanced animation techniques: inverse kinematics

- See
  - CS3451/CS6491: Computer Graphics
  - CS4496/CS7496: Computer Animation
  - CS4475: Computational Photography
  - CS4480 Digital Video Special FX

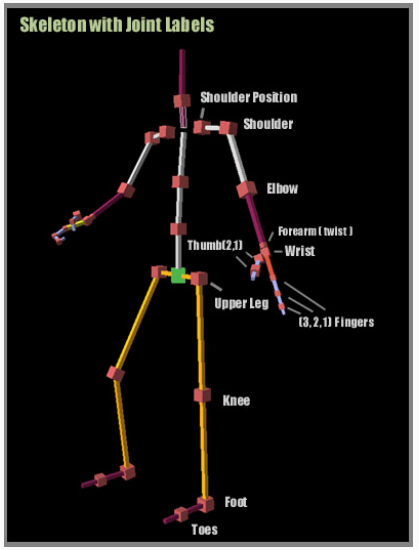

Image from www.3dkingdoms.com/ik.htm

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This is WILL be a course on…

- Emphasis will be on games that simulate and depict “realistic” animated 3-D environments
  - Algorithms
  - Architectures
  - Programming paradigms
- Practical target platforms
  - Xbox 360
  - Playstation 3
  - Windows PCs with NVIDIA or ATI graphics cards
- Future target platforms
  - Intel’s Larabee
- What about the Wii?

Then vs. Now

- In the early days of computer games, the “designer” and the “programmer” were often one and the same
- Nowadays there are usually separate positions of “producer,” “lead designer,” “lead artist,” “lead programmer,” etc.

Theme 1

- Hardware features influence game design
- If the Atari 400 gives you 4 sprites, you'll naturally find something to do with those 4 sprites
- If a Playstation 3 can push a gazillion polygons, developers feel obligated to provide a gazillion polygons
    - Driving budgets through the roof
    - 100 person teams - 30 programmers, 70 artists
    - Trend not sustainable!
    - With all the emphasis on 3-D realism, could great games like Ms. Pac-Man or Balance of Power be made today?

Theme 2

Sufficient cleverness can sometimes overcome hardware limitations

Commercial game industry is brutal

- Nov. 2004: “EA Spouse” post (ea-spouse.livejournal.com) lead to $14.9 million award for unpaid overtime

Erin Hoffman

- Some companies get hundreds of resumes per week per listing (www.gamasutra.com/features/20050711/mcshaffry_01.shtml)

Photo from Wikipedia

Think “outside the box”

- Computer engineering
  - Gaming drives technological developments
  - Gaming experience gives future computer engineers insight
  - Maybe you’ll work for NVIDIA or ATI?
  - Maybe you’ll work for Intel, AMD, or IBM?
  - Maybe you’ll help design the Playstation 4 or Xbox 720?
- “Game” programming/design: think beyond the commercial industry
- Scientific potential of GPGPU
- Even if you never program any “games,” **multicore is the future**
- That all said - we’d be totally thrilled if you got a job at Insomniac, Bungie, Blizzard, Activision, LucasArts, etc.

Many opportunities for indie developers (1)

- On-line distribution takes manufacturing costs out of the equation
- “Brick & mortar” stores have limited shelf space
- Services like Amazon, Netflix, etc. can exploit “the long tail”

- Why are we still shipping boxes mostly full of air?

Photos from http://cribbster.wordpress.com/2009/01/27/

Many opportunities for indie developers (2)

- Greg Costikyan's Manifesto! Games
- Jeff Vogel of Spiderweb Software
  - Old-school RPGs
  - Exile, Nethergate, Avernum, Geneforge
  - www.spiderwebsoftware.org
  - Makes house payments, feeds kids

From www.costik.com

From www.spidweb.com/misc/jvogel.html

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Consoles hostile territory for indie devs (1)

- To sell games on a console, you still must pass the gatekeepers at Sony, Microsoft, and Nintendo
- Code must be “digitally signed” to run
  - Piracy concerns
  - Consoles supposed to provide safe environment
    - Unlike PC users who are used to dealing with viruses, spyware, crashing programs
    - Manufacturers worried about “untrustworthy” code screwing up people’s consoles
    - Want to ensure a uniform, “quality” experience
- **They have more lawyers than you**

Consoles hostile territory for indie devs (2)

- Nintendo NES “pioneered” business model
  - Typically sell consoles at a loss
  - Charge royalty on units **manufactured**, not units sold
- For indie developers, online distribution (Xbox Live Arcade, Playstation Network, WiiWare, etc.) seems like the least risky option
- New: XNA Community Games!

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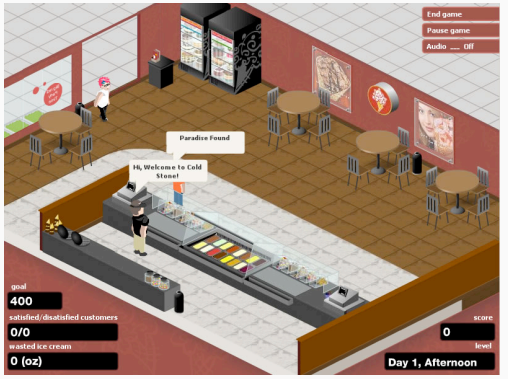
“Serious Games”

- Games for “training” and “education”
  - First responders: “Hazmat: Hotzone”
  - Medicine: “Pulse!!”
  - Business: “Stone City” for Cold Creamery



- Ian Bogost (LCC) doesn’t like the term “serious games”

Screenshots from
www.gamasutra.com/features/20051102/carless_01b.shtml
www.businessweek.com/innovate/content/apr2006/id20060410_051875.htm
www.persuasivegames.com

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“Persuasive Games” & “Games for Change”

- Expand the “Serious Games” notion to include broader categories like “advertising,” (advergame), “propaganda,” “subversion”
- The Howard Dean for Iowa game
- Disaffected! (not authorized by Kinkos)

Pics from www.persuasivegames.com

Info from Ian Bogost, “Persuasive Games”

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America's Army

- Training, advertising, or propaganda?
- U.S. government spent $7 million, but free to play
- Made with Unreal Tournament engine

Pics from Wikipedia

Info from Ian Bogost, "Persuasive Games"

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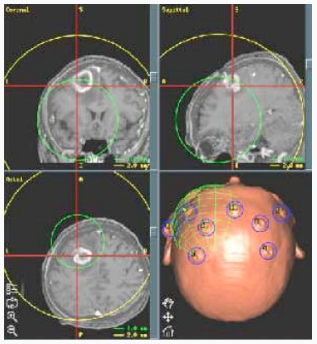
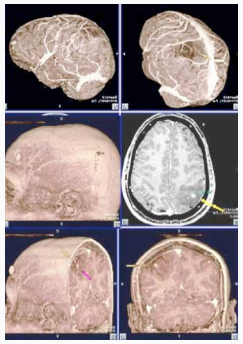
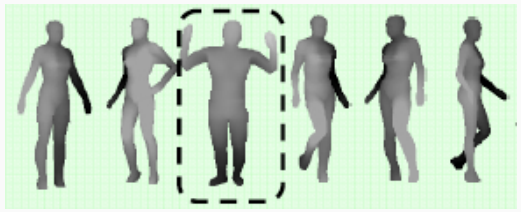
Other real-time applications

- Graphics
  - MRI in the operating room





- Processing
  - Machine vision
    - Toshiba demos: real-time face tracking, markerless motion capture, hand gesture user interface



  - Data compression/decompression
    - New Toshiba HDTVs will use Cell processors
  - Radar signal processing
    - 7 SPE Cells -> PS3s; 8 SPE Cells->Mercury Computing blades

Images from sti.cc.gatech.edu/Slides/Masubuchi-070618.pdf and http://www.radiology.uiowa.edu/NEWS/Haller-PDF.pdf

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Hollywood

- Final ray-traced renderings usually done off-line using “render farms”
- Continually improving real-time graphics lets moviemakers more easily experiment via “pre-viz”
  - Both on CGI-intensive sequences and live-action sequences

http://www.youtube.com/watch?v=iaVj_Q0dkCc

Machinima – filmmaking with game engines

Michael Nitsche (LCC)

Rooster Teeth's Red vs. Blue
From www.spectrum.ieee.org/computing/hardware/machinimas-movie-moguls