6.189 Multicore Programming Primer, January (IAP) 2007

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Lecture 16

Introduction to Game Development

Introduction to Game Development (on the Playstation 3 / Cell)

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Different Types of Game Development

- Casual
- Console
- PC
- Handheld
- Cellphone
- Single Player
- Multi Player

Console Development Priorities

- The code itself is not that important.
- The design of the data affects performance more than the design of the code.
- Ease of programming is either a minor or non-priority.
- Portability is not a concern.
- Performance is still king.

Development Team

- Artists
  - Animation, Shader, Texture, Modeling
  - Environment, Lighting, ...
- Designers
  - Systems, Level, ...
- Writers
- Producers
- Programmers
  - Gameplay, Engine, AI, Special Effects,
  - Sound/Music, ...

What Impacts Game's Technical Design?

- Type of game
- Framerate
- Schedule
- Cost
- Hardware
- Compilers
- ...

- How does this affect code reusability?
- How does this affect cross-platform design?

What are the major game modules?

- Memory management
- Math
- Collision
- Physics
- Static graphics
- Animation
- Procedural graphics
- Lighting
- Loading, streaming
- Scene graph
- AI
- Compression
- Sound, Music
- Special Effects
- State machines
- Scripting
- Motion control
- ...

Overview

- How does programming on the Playstation 3 affect the (macro) design of the major systems?
- Overview of design process for a specific system (Animation).

Structure Design (1)

- Conventional structures are (surprisingly?) needed very little in engine-level SPU code.
  - Data is compressed
  - Data is sorted by type (i.e. Fewer flags)
  - Data is organized into blocks or streams
  - Data is accessed only in quadwords

Structure Design (2)

- Organize data carefully:
  - Prefer fixed (known) size blocks
  - Fundamental unit: 128 bytes (Cache line)
  - Fundamental unit: 16 bytes (Quadword)
  - Prefer uniform data
- Minimum working sizes:
  - 4 x 2 x 64 bits
  - 4 x 4 x 32 bits
  - 4 x 8 x 16 bits
  - 4 x 16 x 8 bits
  - 4 x 128 bits

Basic Math

- e.g. Vector Class
  - Usually the first thing a programmer will make, but consider:
    - SIMD, Altivec vs. SPU instruction set
    - Floats vs. Double vs. Fixed-point
    - SPU floating-point format
    - Component access
  - ... There's no value here.

Memory Manager

- Static allocation is preferred to dynamic
- Most data patterns are known in advance
- When designing allocator, consider:
  - Page sizes
  - LRU is most common, but pretty bad.
  - Hierarchy of allocations
  - Fragmentation is a non-issue for well planned architectures
  - Remember cache line alignment.
  - SPU transfer blocks, 16K

Collision Detection

- Affects high-level design
  - Deferred results
  - Grouped results
- SPU decomposition for:
  - Static geometry in scene
  - Dynamic geometry in scene

Procedural Graphics

- Patch size
- Filter types
- Sync of source reads
- Sync with GPU
- SPU vs. RSX
- Particles
- Cloth
- Fonts
- Textures
- Parametric geometry
- ...

Geometry databases

- No scene graph
- Domain information linked by key
- Cache and TLB affect design choices
  - e.g. Static geometry lookup (Octree, BSP, etc.)
- Geometry lookups on SPU
  - Spatially pre-sort
  - Multiple simultaneous lookups

Game Logic

- State machines
  - Size affected by SPU
  - Deferred results
  - Logic lines can be deferred
- Scripting
  - Interpreter size
  - Multiple streams to hide memory accesses
- Motion control
  - High-level sync (Animation, AI, Physics)

Animation (1)

- Starting with the basics:
  - Simple playback, animation channels
    - Related data
    - e.g. Rotation + Translation + Scale = Joint
  - Euler vs. quaternion
    - Euler: More compressible
    - Quaternion: Less messy
    - Gimbal lock is manageable in practice.
  - Format, double vs. float vs. half vs. fixed-point
  - Rotations: Degrees, radians or normalized?

Animation (2)

- Animation frame storage
  - Basic 9 channels (raw)
  - Uniform channels
    - Plus uniform channel map
    - Plus uniform channel count
  - X Number of joints
  - Decide on max channels

Animation (3)

- Channel curve fitting
  - Closer to root, tighter fit.
  - e.g. Simple spline
    - Store time values
    - Problem: Looping scalars
    - Problem: Unlimited length

Animation (4)

- e.g. Spline segments
  - Plus storage for time maps
  - Plus segment lookup time
  - Advantage: Can re-order blocks
  - Advantage: Long lengths OK
  - Disadvantage: Less compressable
  - Advantage: Solves scalar loop problem
- Summarize: DMA and transform.

Animation (5)

- e.g. Adding dynamic channel support
  - Add uniform data table
    - Maximum dynamic channels with linkage, or...
    - All uncompressed
  - Add (simple) contraints
    - Max change
    - Max range
    - Max acceleration (impacts storage)
  - Blend information
  - Summarize: DMA and transform.

Animation (6)

- More on mixing:
  - Phase matching
  - Transitions
  - Translation matching
- Drawing animated geometry
  - Single or double buffer joints:
    - Single: Requires more organization
    - Double: More memory, more flexible.

Optimization

- Required for practice
- Impacts design
- NOT the root of all evil