Ray Tracing using Programmable Graphics Hardware

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Outline

- Using Cg with OpenGL
  - Where does Cg fit in?
  - Benefits of Programmable Graphics Hardware
- Mapping applications as Graphics processes
  - General purpose processing on the GPU
  - Ray Casting model
  - Extensions
OpenGL Graphics Pipeline

3D Application → 3D API: OpenGL or DirectX → GPU Front End → Primitive Assembly → Rasterization & Interpolation → Framebuffer Tests → Framebuffer

Programmable Vertex Processor → Programmable Fragment Processor
Cg Application model

- Cg - high level, c-like language
- Cg compiler to generate assembler
- Cg Runtime
- Communication with Hardware

Mark et al. SIGGRAPH 2003
GPU Performance

GPU Performance (32 bit AA Fill Rate)

CPU Performance (Megahertz)

Sourced from NVIDIA
Cg Processing model

- Application
  - Input Registers
  - Vertex Program
  - Output Registers
  - Register Interpolation
- Rasterization
  - Input Registers
  - Fragment Program
  - Output Registers
- Display
  - Textures
Example: Image Filter

- Draw screen-sized quad
- Input image to be processed as texture
- Edge-detection fragment program is run once per pixel
- Output results to screen or save to texture

Images sourced from NVIDIA
Cg code example

half4 main(half2 coords: TEX0,
sampler2D texture) : COLOUR {
  const half offset = 1.0 / 256;
  half4 c = tex2D(texture, coords);
  half4 bl = tex2D(texture, coords + half2(-offset, offset));
  half4 l = tex2D(texture, coords + half2(offset, 0));
  ...
  half4 b = tex2D(texture, coords + half2(0, offset));
  return 8 * (c + -0.125 * (bl + l + ... + b));
}
Ray Tracing model
Current Ray Casting method

- **Render to Texture** used to store results
- **Updated intersection texture set as input for next pass**
Extensions

- Full recursive model
- Different rays can be in different states
- State based processing
- Limiting processing to one type of ray
- Application for method: Constructive Solid Geometry
Summary & Questions

- OpenGL Graphics Pipeline
- Cg Application & Processing models
- Example: Image Filter
- Ray Tracing model
- Current Ray Casting method
- Results
- Extensions