HDR in Valve’s Source Engine

SIGGRAPH 2006

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Overview

- Intro to HDR
- Reflection/Refraction
- Tone Mapping and Auto-exposure
- Road to a shippable HDR implementation
Why HDR?

Paul Debevec's *Rendering with Natural Light*

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What is *Lost Coast*?
Source HDR Radiosity Lighting from the Sun

Bounced Sunlight
Light sources and light maps
Real-World Sky at Multiple Exposures

f22 @ 1/1600th second  f22 @ 1/250th second  f22 @ 1/40th second
Scene from Source Engine/\textit{Lost Coast}
Authored HDR Skybox
HDR cube maps

Environment probes placed in Level Editor
HDR cube maps
HDR cube map reflection
HDR water reflection and refraction
General Refraction
Tone Mapping and Auto Exposure
Tone Mapping and Auto Exposure
Without Blooming
Criteria for evaluating HDR methods

- MSAA Compatibility
- Alpha-blending Compatibility
- HDR blooming
- HDR reflection/refraction
- Bilinear filtering
- Customer hardware support
- Memory requirements
- Performance
Ideal Implementation

- HDR Textures
- HDR Lights
- HDR Render Targets
- HDR Frame Buffer
- HDR Blooming
- Tone Mapping
- Displayable Image

Processes:
- HDR Copy
- Refractive Copy
- HDR Representation
- RGB LDR
RGB-Scale HDR Implementation

- Demonstrated in Fall of 2003
- \( \text{HDR color} = \text{RGB} \times (\text{A} \times 16) \)
RGB-Scale HDR Tradeoffs

- **Pros:**
  - MSAA works
  - works on all DirectX 9 hardware
  - HDR Blooming

- **Cons:**
  - alpha blending very difficult
  - bilinear filtering doesn't work
  - extra conversion of frame buffer
MRT HDR Implementation

- 2 MRT buffers/textures per HDR resource

- HDR Textures
- HDR Lights
- HDR Render Targets
- Tone Mapping (pixel shader)
- HDR Frame Buffer
- HDR Blooming
- Displayable Image

Flow:
- RGB888 * 2 Pre tone map
- RGB888 * 2 Post tone map
- RGB888 LDR
MRT HDR Tradeoffs

➢ **Pros:**
  • Main motivation: alpha blending works.
  • bilinear interpolation works
  • works on all DirectX 9 hardware

➢ **Cons:**
  • MSAA doesn't work
  • HDR textures, render targets, etc take twice as much space.
HDR textures and render targets are all 16-bit floating-point RGB.
Floating Point HDR Tradeoffs

- **Pros:**
  - HDR Blooming
  - HDR refraction
  - Improved tone mapping

- **Cons:**
  - Requires fp16 alpha blending
  - Bad performance
  - Tons of memory
  - MSAA doesn’t work
  - **GOTCHA! Floating point SPECIALS!!!**
Valve Integer HDR Implementation

- HDR Textures
- HDR Lights
- Tone Mapping (pixel shader)
- LDR Frame Buffer
- LDR Blooming
- Displayable Image

- HDR Render Targets

- Fp16 float or integer RGB textures
- Refractive Copy
- 16-bit HDR RGB
- RGB888 LDR
Valve Integer HDR Tradeoffs

**Pros**
- Works on all DX9 hardware
- Lower memory requirements
- Very fast!
- Supports MSAA on all hardware
- No specials to deal with!

**Cons**
- LDR Blooming
- LDR Refraction
Valve Integer HDR blooming

color + Luminance(color) * color =

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HDR water with Valve Integer HDR
General Refraction/Valve Integer HDR
Auto Exposure
Tone Mapping with Valve Integer HDR

Tonemap scale = 0.5
Tonemap scale = 1
Tonemap scale = 8

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Beyond Linear Scale Tone Mapping

- Dark scenes with high exposure: desaturate
- Use Color Correction
- For more info, check out Jason Mitchell’s talk in the “Advanced Real-Time Rendering in 3D Graphics and Games” course on Tuesday in room 156.
Desaturation via Color Correction

Original Image

Desaturated
HDR and Authoring

- Bloom amount and exposure range
- Asymmetric autoexposure
Team Fortress 2: NPR + HDR!
Conclusion

- Intro to HDR
- Reflection/Refraction
- Tone Mapping and Auto-exposure
- Road to a shippable HDR implementation
Publicly available SDK

Academic licenses provide

- Access to Valve games
- Source code
  - HLSL shaders, Radiosity and visibility calculations
  - AI system, path finding
  - Animation system, acting system, inverse kinematics
- Production quality art and sound assets
- Useful level and modeling tools
  - Hammer level editor, Faceposer, Model viewing utilities

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