E8371

Simulating Lighting Conditions in Production Ergonomics with NVIDIA OptiX

Andreas Dietrich, ESI Group
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AGENDA

Introduction
Helios Rendering Architecture
OptiX Backend
AI Denoising
Ray Tracing on HMDs
Example Applications
Demo
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Introduction

Production Ergonomics

• Ergonomics important aspect of
  • Manufacturing systems
  • Maintenance procedures

• Visibility under real world lighting conditions
  • Affects efficiency of human operators

• Need to simulate light propagation
  • Monte-Carlo path tracing
  • GPU accelerated
HELIOS RENDERING ARCHITECTURE
Helios Rendering Architecture

Requirements

• Lightweight
  • Not a full-blown scene graph, let application handle this
  • Replicate as few data as possible

• High performance
  • Exploit specific/low-level GPU features
  • Must be able to get close to the metal

• Extensible
  • Leverage external rendering frameworks, such a NVIDIA RiX or OptiX

• Support for various rendering algorithms
  • Rasterization, ray tracing, hybrid modes
  • CAD rendering, photo-realistic rendering, scientific visualization, …
Overview

- Helios renderer supports a variety of rendering technologies

- Encapsulated in Backends, e.g.,
  - RiXGL: rasterization
  - OptiX: ray tracing

- Backends as dynamic libraries (DLLs)
  - Loaded and unloaded at runtime
  - Can be switched arbitrarily

- Helios controls render graph, e.g.,
  - Hybrid rendering
  - Frame composition
OPTIX BACKEND
Helios OptiX Backend

Overview

• Based on NVIDIA OptiX:
  • Programmable GPU ray tracing pipeline
  • Single-ray programming model using C++
  • AI accelerated rendering

• Implements a range of physically based rendering algorithms
  • Whitted ray tracing, Ambient Occlusion, Global Illumination
  • Generates precomputed lighting data (e.g., texture baking)
  • Separation of BSDF and integrator code (surface shading / light transport)
  • Supports Material Definition Language (MDL)
Overview

Helios OptiX Backend

Helios

MDL Manager
- Reads MDL files
- Generates material expression tree and parameter lists
- Generates BSDF programs (PTX assembly language)

OptiX Backend

OptiX Programs
- Ray generation and hit programs
- Integrators call BSDF programs

MDL SDK

OptiX
Helios Objects
Scene Hierarchy Flattening

Application graph

Backend graph

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Helios Objects

Shared Geometry and Appearance

Single object

- T1
- O1
- G1
- A1

Two object instances

- T2
- O2
- G2
- A2

- T3
- O3
OptiX Node Graph

Helios Objects as OptiX Node Graph

- Two-level acceleration hierarchy
- Increased performance when using RTX
OptiX Node Graph

OptiX Programs

- Transform
- Geometry Group
- Acceleration
- Geometry
- Geometry Instance
- Material
- BoundingBox Program
- Intersection Program
- ClosestHit Program
- AnyHit Program
Motivation for using MDL

Future-Proof Material Handling

- Realistic appearance
  - Physically based rendering
  - Support of measured materials
  - Material layering (e.g., clear coating over wood)

- Exchangeability and flexibility
  - Consistent look across renderer, platforms, applications
  - Vendor, renderer and platform independence
  - Share centralized material assets
  - Use of material libraries by 3rd-party providers
AI DENOISING
Global Illumination

Stochastic Monte-Carlo Noise

- Global illumination path tracer
  - Computes indirect light transport
  - Monte-Carlo sampling
    - Solves high-dimensional integrals
    - Exhibits stochastic noise
  - Takes long to generate smooth images
AI Denoising
OptiX Postprocessing

• Postprocessing pipeline since Optix 5.0

• OptiX command list consists of
  • Kernel launch stages
  • Postprocessing stages
    • Tone mapping
    • Denoiser filter

• Denoiser stage
  • Deep neural net (uses Tensor cores)
  • Trained to detect and remove noise

Command list
Deep Learning Denoiser
Filtering Noise in Postprocess

Plain path tracing (20 iterations)  Path tracing + denoiser (20 iterations)
RAY TRACING ON HMDS
Ray Tracing on HMDs

Example

• Whitted style ray tracing possible on HMDs

• Helicopter cockpit
  • 180,000 triangles
  • 1 point light source

• Example setup
  • Oculus Rift
  • Quadro RTX 6000
  • OptiX 5.1 + RTX
  • 40 – 80 frames per second
EXAMPLE APPLICATIONS
Example Applications

Lighting Conditions in Micro-Factory

- Gazelle Tech micro-factory
  - Local car assembly
  - Relocation of production to customers
  - Suited for emerging countries

- Workspace Lighting
  - Illumination in tight spaces
  - Depends on local environment
  - Changes when factory is moved
Lighting Conditions in Micro-Factory
Global Illumination Simulation

IC.IDO 12.1 on Quadro RTX 6000
Lighting Conditions in Micro-Factory
Global Illumination Simulation

IC.IDO 12.1 on Quadro RTX 6000
DEMO
THANK YOU