Enabling Next-Gen Effects through NVIDIA GameWorks New Features

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Overview

- GPU Rigid Bodies (GRB)
- FleX
- Flow
- WaveWorks
GPU Rigid Bodies in PhysX 3.4

- A new feature introduced in PhysX 3.4
- Implemented in CUDA
- Supports Windows and Linux with NVIDIA Kepler (GTX 6 series) GPU or later
- Same API and semantics as CPU PhysX rigid bodies
- Supports most PhysX rigid body features except articulations
GPU Rigid Bodies in PhysX 3.4 cont.

- Hybrid CPU/GPU rigid body simulation
- Execute the following rigid body pipeline stages on GPU
  - Broad phase
  - Narrow phase
  - Solver
  - State management
  - Bounds computation
- Execute the following stages on the CPU
  - Island management
  - Shape filtering
  - CCD
  - Triggers
  - User callbacks
Performance Results

Test Platform
- Windows 10 64-bit
- I7-5930k
- 32GB RAM
- GTX 1080
13,824 Convex Objects

![Graph showing performance comparison between PhysX 3.3, PhysX 3.4, and PhysX 3.4 GPU for 13,824 convex objects.](image-url)
Hallway (16,000)
Arena Demo (15,000)
Kapla Tower 20,000 convexes
700 Ragdolls

Time in milliseconds

- PhysX 3.3
- PhysX 3.4
- PhysX 3.4 GPU
Overview

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FleX In Funhouse
Motivation

- Too many solvers
- Creates redundant work
- Want one optimization target
- Want two-way interaction between all object types
Core Idea

Everything is a set of particles connected by constraints
Advantages

- Simplifies collision detection
- Stable two-way interaction of all object types:
  - Rigid Bodies
  - Deformables
  - Liquids
  - Cloth
- Fits well on the GPU
Particles

```
struct Particle
{
    float pos[3];
    float vel[3];
    float invMass;
    int phase;
};
```

- Phase-ID used to control collision filtering
- Single collision radius
Constraints

Constraint types:
- Distance (clothing)
- Shape (rigids, soft bodies, plastics)
- Density (fluids)
- Volume (inflatables)
- Contact (non-penetration, friction)

Combine constraints to create wide variety of effects
- Melting, phase-changes
- Stiff cloth
FleX new features

- New buffer-centric API
- New collision shape API
- Add support for CUDA 8.0
- Add support for D3D 11/D3D12
- Local space simulation
Local Space Simulation

Particles inside an attached parent frame are updated by inertial forces

Without

With
Enable Local Space Simulation in UE4

Step 1
Make the FleX component a child of the object it should be parented to.
Enable Local Space Simulation in UE4 cont.

Step 2
Enable the Local Space simulation option on the FleX component
Enable Local Space Simulation in UE4 cont.

Step 3
Enable Is FleX Parent on the parent object
Enable Local Space Simulation in UE4 cont.

Step 4
Set the linear and rotational inertial strengths
Comparison

Global Space Simulation

Local Space Simulation
UE4-FleX Cloth

- Environmental cloth
- CCD Triangle Tests
- Auto-attachment to static or dynamic actors
- Inflatable constraints
UE4-FleX Ropes

- Based on built-in UCableComponent
- Supports bending / self-collision / world collision
UE4-FleX Force Fields

- Integration with UE4 URadialForceComponent
- Scriptable with Blueprints
- Applied in CUDA through FleXExtensions
Interop between PhysX

- Two-way interaction between FleX<->PhysX
- FleX actors insert bounds into PhysX scene
- Overlap query per-FleX Actor
- Allows CCT to interact with FleX objects
Create a simple cloth demo with UE4-FleX
Overview

- GPU Rigid Bodies (GRB)
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FLOW

Features:
- Combustible fluid, fire and smoke
- Dynamic grid simulator
- D3D11 and D3D12 support
- Volume rendering
Create a grid
NVIDIA Flow In Unreal Engine 4 cont.

Create an emitter
NVIDIA Flow In Unreal Engine 4 cont.

Setup Flow Material and Flow Render Material
Create a simple fire demo with UE4-Flow
Overview

- GPU Rigid Bodies (GRB)
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Agenda

- UE4 WaveWorks Overview
- UE4 WaveWorks key features
- UE4 WaveWorks core components introduction
- How to use WaveWorks in UE4
Enable developers to deliver a cinematic-quality ocean simulation for interactive applications
Integrated to UE4 now
Completed tools to create ocean and lake
More features are coming ...
https://www.youtube.com/watch?v=DhrNvZLPBGE
Key Features

- Completed ocean’s simulation and rendering systems
  - Foam’s simulation and rendering
- Shoreline effect
- Realtime physics feedback
- Tessellation
- Quad-tree tile-based LoDing
- Also can be used to create lake
WaveWorks Asset

- Create WaveWorks Asset
- WaveWorks Asset details panel
  - WaveWorks simulation parameters
  - Shoreline parameters
WaveWorks Actor, Component

WaveWorks Actor

WaveWorks Component
Distance Field Texture

- **R**: distance to shoreline
- **G**: depth
- **B, A**: gradient
Shoreline

- Create Distance Field Texture
  - Set Capture Actor’s Position
  - Fill the parameters
  - Click “Capture Scene” button
Ocean’s Rendering
- Reflection
- Refraction
- Specular
- Foam
Rendering

- WaveWorks material node
  - Foam attributes
  - World normal
  - Un-displaced world position
  - Vertex’s displacement
  - Distance to shoreline
Physics Feedback

- Sample displacement
- Get intersection point between ray and ocean
WaveWorks StaticMesh Component
Workflow in UE4

PlanarReflection Component

WaveWorks Asset

Distance Field Texture

Ocean Material

WaveWorks Actor

WaveWorks Component
Join the GameWorks developer program

- If you don't have an account on developer.nvidia.com or are not a registered member of the NVIDIA GameWorks developer program then register here: http://developer.nvidia.com/registered-developer-programs

- If you are logged in, accept the EULA and enter your GitHub username at the bottom of the form: https://developer.nvidia.com/gameworks-source-github
https://github.com/NvPhysX/UnrealEngine/tree/WaveWorks-4.16

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