

Rendering of 3D Dynamic Virtual Environments

S. Catanese[†] E. Ferrara[‡] G. Fiumara[†] F. Pagano[⌘]

[†] Department of Physics
University of Messina

[‡] Department of Mathematics
University of Messina

[⌘] Dept. of Information Technology
University of Milan

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Outline

- 1 Motivation
 - The Basic Problem That We Studied
 - Previous Work

- 2 Our Results/Contribution
 - Design & Evaluation
 - Show-case
 - Main Results

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Introduction

- How to design a virtual environment?
 - ▶ Context (e.g., videogame, augmented reality, virtual reconstruction, simulation of physics effects, ...)
 - ▶ Required degree of realism (e.g., HQ graphics, physics included)
 - ▶ Type of interaction
 - ★ Static simulation? Interactive
 - ★ Dynamically interactive (kinect, ps move, wii)
 - ★ Augmented reality via devices (tablet, ...)
 - ★ Online interaction (mmo videogames)
- On which characteristics should we focus?
 - ▶ Graphics
 - ▶ Physics
 - ▶ Interaction
- It is possible to support this process? At which level?
 - ▶ Framework
 - ▶ Middleware
 - ▶ Libraries
 - ▶ GUIs & IDEs

Goals and Motivations

- Design a framework to support
 - ▶ Non-commercial videogames design
 - ▶ Academic experimentation
 - ▶ Virtual environments simulation
- Exploiting open-source components, in order to:
 - ▶ Shorten the design process
 - ★ Facilitating the development
 - ★ Letting developers focus on aspects such as gameplay, game mechanics, etc. instead of technicals
 - ★ Introducing a level of abstraction w.r.t. adopted libraries
 - ▶ Develop from scratch required components not already existing as open-source solutions
- With the following characteristics:
 - ▶ 3D rendering
 - ▶ Physics effects
 - ▶ Environmental effects
 - ▶ I/O, sound, scene, network management
- Show-case demo of capabilities of the framework

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Related Work and Fields of Application

Main Topics:

- Virtual Environments
 - ▶ Virtual Reality
 - ▶ Augmented Reality
 - ▶ Virtual Tours/Museums
 - ▶ Virtual Reconstructions (Archeological, Historical, ...)
- Games
 - ▶ Academic Applications
 - ▶ Commercial Videogames
- Simulations
 - ▶ 3D Simulations
 - ▶ Engineering/Architectural Rendering (3D CAD, ...)
 - ▶ Physics Simulations

Related to this work:

- “A Framework for Supporting Design and Development of 3D Online Games”
(under review, SCCG 2011)
- “An Academic Framework for Designing 3D Virtual Environments”
(under review, Smart Graphics 2011)

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Architecture of the Framework I

Components

- Rendering Engine
 - ▶ Direct3D & OpenGL Rendering Pipelines Implementation
- Scene Manager
 - ▶ Bounding Volumes Hierarchies, Binary Spatial Partitioning, Octrees, ...
- Physics Engine
 - ▶ Collision Detection
 - ▶ Environmental Phenomena
- Character Controller
 - ▶ Encapsulation Model, Ragdoll Rigid-body System, ...
- Networking
 - ▶ Multiplayer Sessions, VoIP Sessions, ...

Architecture of the Framework II - Tools

- Blender (Scene Designer) + physics exporter plugin
- ExtendedDotScene (Scene Manager) + physics extension
- PhysX (Physics Engine)
 - ▶ Caelum (Sky manager)
 - ▶ ParticleUniverse (Particle System Manager)
 - ▶ Weather Simulator (Weather Manager)
 - ▶ Hydrax (Fluid Dynamics Manager)
 - ▶ Paged Geometry (Static/Dynamic Geometry & Lighting Manager)
- OGRE (Rendering Engine) + new graphics algorithms (e.g., texture splatting, parallax mapping)
- OpenAL (3D Audio Library)
- RakNet (Networking Library)
- OpenIS (I/O Manager)

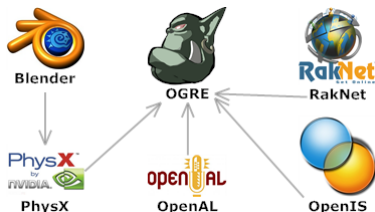


Figure: Adopted tools

Architecture of the Framework III

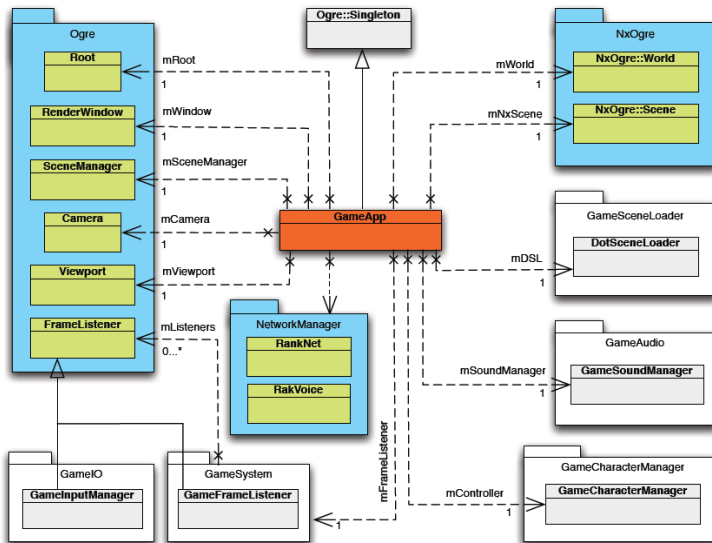


Figure: Class diagram representing components of the Framework

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Description of the Show-case

Characteristics included in the demo

- Terrain and Scene generation and management
 - ▶ Maps (heightmaps, density maps, coverage maps, color maps)
 - ▶ Outdoor Scenes Generation (via Terrain Generator)
 - ▶ Indoor Scenes Design (via Blender)
- Improved rendering techniques
 - ▶ Parallax Mapping, Texture Splatting
- Skydome simulation
 - ▶ Dynamic sky simulation (clouds, sun/moon, astronomical starfield)
 - ▶ Day-night cycle simulation, dynamic lighting, ...
- Particle system simulation
 - ▶ Fuzzy phenomena (rain, clouds, water, ...)
- Weather simulation
 - ▶ Environmental atmospheric effects
- Fluid dynamics
 - ▶ Dynamics of fluids (water, ...) and interactions
- Geometry Simulation
 - ▶ Static/Dynamic Level of details management

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Figure: Dynamic lighting and fluid dynamics (Hydrax + PagedGeometry)

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Figure: The weather simulation: rain (Weather Simulator + ParticleUniverse)

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Figure: The skydome simulation: day-night cycle (Caelum)

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Figure: Clouds system: clouds and skydome (Caelum + Weather Simulator)

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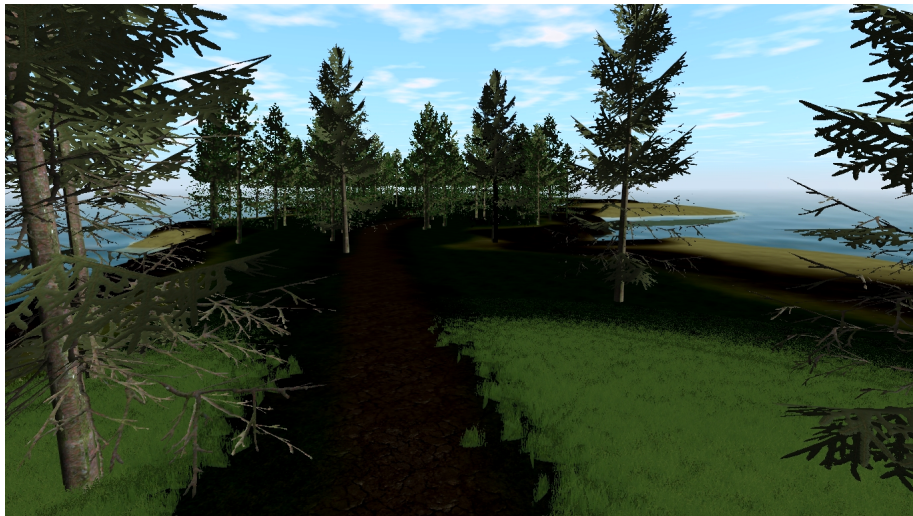


Figure: Level of Details balancing and Static Geometry (Paged Geometry)

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Figure: Lighting and reflections on water (Caelum + Hydrax + Weather Sim.)

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Main Results I

- Design of a framework for supporting design and development
- Introduction of levels of abstraction w.r.t. adopted tools and libraries
- Extension of 3D rendering engine with the support of physics and environmental effects

Hint:

- The modular structure of the framework allows further expansions and personalization
- The platform is released open-source ¹

¹<http://informatica.unime.it/velab>

Main Results II

- A new library from scratch for simulating and managing the weather
- A new scene format “Extended DotScene” DTD Definition
- Integration of six open-source components “writing” new interfaces
 - ▶ Blender $\leftrightarrow$ PhysX
 - ▶ OGRE $\leftrightarrow$ PhysX
 - ▶ OGRE $\leftrightarrow$ OpenAL
 - ▶ OGRE $\leftrightarrow$ OpenIS
 - ▶ OGRE $\leftrightarrow$ RakNet

Hint:

- The show-case illustrates the potential of the framework

Summary

- Extensible framework
- 3D dynamic environment show-case
- Simulation of physics effects

Future Work

- New graphics techniques (Tessellation, ...)
- Improved realism (Simulation of new phenomena, ...)
- Extension to different fields of application (Virtual Museums, Virtual Reconstructions, ...)