instantReality
Framework for AR and VR application

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Introduction and Motivation
System-feature and Architecture
Application example
Current status and future developments
Introduction and Motivation
Fraunhofer Foundation

57 Institutes doing application oriented research and development

Fraunhofer Foundation
Mission: “Application oriented research for industry and advantage of our society “

Figures 2008
80 research units
57 Institutes
15 200 Employees
1.4 Billion € Budget

2/3 research projects for industry
1/3 public funding

Institute for Computer Graphics, Darmstadt
120 Employees
20 Employees in VR/AR Group
1st Generation
1992 start of VR-Activities

2nd Generation
1995 1st Fraunhofer VR System (coop VW/BMW)
1997 First 5 sided CAVE in Germany
1998 Founding VR-Spinoff: VR-COM

3rd Generation
2000 OpenSG (LGPL Scene Graph)
2003 HEyeWall 1.0 (18 Million Pixel, 48 PCs)
2005 InstantReality VR/AR Middleware
2008 HEyeWall 2.0 (35 Million Pixel, 48 PCs)
System-feature und architecture
Requirements for the 3rd gen system

Problem: Wide variety of topics and feature-requests

Distributed Systems
Multi-Core/GPU
Indoor-AR
Outdoor-AR
Multi-Sensor net.
Large-Model vis.
Dialog-systems
Edutainment
Prototyping
Requirements for the 3rd gen system

Scalability is key-requirement

Interaction und Navigation:
from: Single local sensor
to: Dynamic and distributed Sensor-Fusion networks

Rendering und Visualisation
from: Mobile systems
to: Distributed Multi-Screen/CPU/GPU-systems

Complexity of the application-logic and behaviour
from: Walkthrough or examine of static data
to: Complex and non-linear edutainment-application
Requirements for the 3\textsuperscript{rd} gen system

Costly application development cycle in 1\textsuperscript{st} and 2\textsuperscript{nd} gen systems

- Fix Application Modules (e.g. Design-Review, Assembly/Disassembly)
- New Modules had to be developed in C/C++
- No clear distinction between application and system development

Efficient and flexible application development is key-requirement

- Application prototyping is imported for Industry and R&D
- Clear cut between system and application development-layer
  - To maximize the functionality in the system layer
  - To minimize the complexity in the application layer
There is no standard for VR/AR Application dev

Our Solution: Utilize standard from close domain

X3D ISO Standard (describes an abstract functional behavior and time-based interactive 3D environment)

- Designed to be extensible
- (Multi-parent) Szenen-Graph
- Behaviour-Graph
- Scripting und Prototyping
- Device independent
- XML/ascii/binary – Data-Encodings
- > 200 node-types in 40 components (e.g. NURBS, Volume-Rendering, Physics (RBD), glsl/cg/cgfx-Shader)
System-feature and architecture

X3D as basis for the application description layer
System-feature and architecture
X3D runtime for AR/AR Application

Desktop runtime
- WIMP environment with mouse & keyboard
- Single screen per application
- Application interfaces only with browser

Immersive VR environment
- No WIMP interface
- Wide range of IO devices and interaction methods
- Multi Screen/Pipe and Cluster setups
- Distributed applications
System-feature and architecture
Interaction and Navigation

High-Level: Virtual Object Sensors
- Device and Device-class independent
- Extents X3D PS-Concept
- Supports Multi-Touch/User/Hand

High-Level: Navigator and NavigationEval

Low-Level: Data-stream Sensors
- Network transparent
- Dynamic reconfiguration
- Support > 30 VR devices
- Vision Subsystem (e.g. Marker- and Natural-Feature-Tracker)
Subsystem for Vision-based tracker

**InstantVision**: Vision-based tracking

- Composing, testing, and tuning of visual tracking pipeline
- Support for marker, poster, and different natural-feature tracker (e.g., line-tracker, KLT)
System-feature and architecture
InstantVision: Robust and Markerless Tracking
System-feature and architecture

InstantVision: Feature reconstruction from 2.5D TOF data
Base-feature of OpenSG
Transparent for Application developer
Support for Sort-First and Sort-Last
Dynamic load distribution
  Fully automatic method
Scales almost linear with any number of CPU/GPU boxes
2x to 5x performance increase with typical CAD data
System-feature and architecture

Generic X3D extensions

Procedural Shapes

  Generative Modelling Language (GML)

Semantic Modelling

Terrain-Rendering

High-level Avatar Controller

Object-to-Object collision detection

Mesh based simulator

  (e.g. MassSpring, CantileverBeam, ...)

Force-Field Evaluator

Steering System

Programmable Particle System
Application example
Design Reviews
VW
Assembly and Disassembly

DLR
HEyeWall (35x MegaPixel wall)
Fraunhofer ZV
Answer
EU Project
Alignment of CAD/Real-Prototypes
Howaldtswerke - Deutsche Werft GmbH

Camera Calibration
Cultural Information System
iTacitus, EU
Human Posture Recognition
Persona: EU

Unlabelled Reference Images → Video Images → Background Subtraction → Silhouette Images → Connected Component Analysis and ROI Detection → Connected Components → Subimage Cropping, Resampling and Vectorization → Feature Vectors → Manual Labelling → Unlabelled Feature Vectors

Unlabelled Feature Vectors → Labelled Feature Vectors → Machine Learning (Locality Preserving Projections) → Projection and Classification → Projection and Classification → Pose Estimates → Offline Processing

Labelled Feature Vectors → Projection and Classification → Pose Estimates → Offline Processing

Online Processing → Context Publisher (Java) → Unknown → Online Processing
Currant status and future developments
instantReality Framework
Development and Runtime-environment

1. Integrate
   - Native CAD Data
   - Maya Plugin
   - 3D Max Plugin
   - X3D Data

2. Compose
   - Application Logic
   - Behavior
   - Cluster Setup
   - IO Setup

3. Deploy
   - Web Plugin
   - Standalone Runtime
   - Server
   - Vis Server
   - IO Server
   - Sound Server

X3D
instantReality Framework
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instantReality Player
Network services
Standard Conformance

- GLSL (Khronos Group)
- CG (NVIDIA Corporation)
- OpenGL 2.0 (Khronos Group)
- JAVA (Sun Corporation)
- SOAP (W3D SOAP V1.2)
- ZEROCONF (IETF Zeroconf Working Group)

Plattformunabhängigkeit

- OpenSG/GL CodeBase: Win32, Unix/Linux, OSX
- OpenGL/ES CodeBase: Windows CE, iPhone
Free Version for non-commercial use

- Beta0; 15 April 2007; First Test Release
- Beta1; 15. June 2007; All OS-Release
- Beta2; 15. July 2007; Web3D SDK Release
- Beta3; 27. December 2007; X-Mas Release
- Beta4; 15. April 2008; Cluster Release
- Beta5; 7. August 2008; IO-SDK Release
- Beta6; 15. March 2009: IEEEVR Release
- Beta7; 23. December 2009; X-Max Release

- First 2.0 15. January 2010
instantReality.org Webpage
Portal for internal and external user

Front Pages

- News
- Project Exhibition
- Info & History
- Release-plan

Developer Pages

- Node/Component Documentation
- Tutorials
- IO-System Documentation
- EAI-System Documentation
- Forum (~200 User)
Project partner from IGD/A4

- IGD-Intern (CAMTECH, A1, A2, A3, A5, A7)
- Fraunhofer-Intern (IAO, IFF)
- > 20 Industrial Projects
- > 10 BMBF Projects
- > 20 EU Projects
Research and Development

- > 5 Fraunhofer Groups
- > 5 Universities in Europa
- MIT (Dep. of Aeronautics and Astronautics)
- Virginia Tech

Industry

- VW
- Daimler
- SAP
- HDW
- DLR
- ...

instantReality User
VR/AR Lectures

- TU Darmstadt
- TU Claustahl
- University College London
- TU Chemnitz
- Uni bielefeld

Tutorials and Classes

- Web3D 08: VR/AR Tutorial
- Siggraph 08: Don’t be a WIMP
- IEEE VR 09: VR/AR Tutorial
Member of „Workinggroups“

- General (Extensions & ISO)
- HAnim (Humanoid Animation)
- Medical (Volume Rendering)

One Member in BOD

Web3D Symposia

- Sponsored by ACM
- 2008: Los Angeles, CA
  - Prof. Fellner: Paper-Chair
- 2009: Darmstadt
  - www.web3d2009.org
  - Prof. Fellner: General Chair
  - Johannes Behr: Paper Chair

A new wave of interactive 3D applications rises from the World Wide Web. New technologies are emerging and existing technologies are evolving to enable the third dimension in web browsers. This also leads to the appearance of a new generation of consumers and producers of 3D content in the new Read-Write Web environment.

14th in the series, the Web3D 2009 International Symposium will address a wide range of topics covering 3D hypermedia on the web. The annual Web3D Symposium is a major event, which unites researchers, developers, experimenters, and content creators in a dynamic learning environment. Attendees share and explore methods of using, enhancing, and creating new 3D web and multimedia technologies, such as X3D, VRML, COLLADA, Croquet, MPEG4, Java3D, and Canvas3D. The symposium will also address new trends such as Interactive 3D graphics applications on mobile devices.

Web3D 2009 will take place at Fraunhofer Institute for Computer Graphics (IGD) in Darmstadt (Germany) close to Frankfurt / Main. The conference is scheduled one week after EUROVIS 2009 (Eurographics/IEEE Symposium on Visualization, June 10 - 12 2009) in Berlin, Germany. With only a weekend in-between this is a chance for overseas visitors to attend both conferences.
instantReality Future developments

Visualisation

- Dynamic Optimisation (BIH)
- Huge Model (out-of-core)
- Server-side retrieval (GEO/GIS)

Distributed Multi-User Systems
Character Animation
Parametric Systems
Fraunhofer IGD

instantReality and OpenSG resources

www.instantreality.org
Beta6 release
30+ Device Handler
Distributed Rendering/IO
IO-SDK
Windows/Mac/Linux

www.opensg.org
LGPL source
Rendering