

blue-c





The blue-c

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12. December 2002

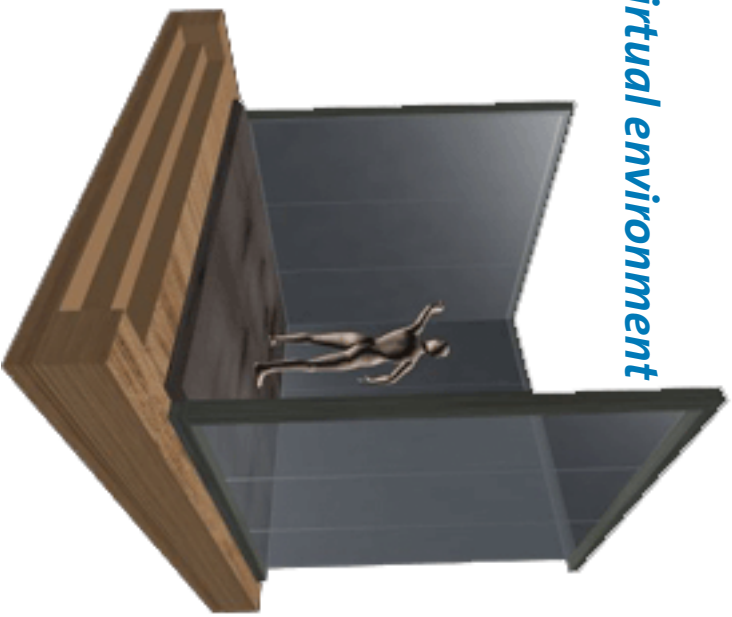
ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

<http://blue-c.ethz.ch>

The blue-c

A collaborative immersive virtual environment



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Program

14:00	<i>Welcome</i>	RZ
14:05	<i>Overview of the project (Prof. M. Gross)</i>	RZ Dog
14:30	<i>Demos in the blue-c portal (M. Näf, Ch. Spagno, S. Lang, S. Würmlin)</i>	RZ Dog
15:00	<i>Wrap - up and discussion (Dr. A. Kunz)</i>	IFW E42

Virtual Reality

- ❧ *Technology migrates into applications*
- ❧ *Build scalable architectures*
- ❧ *Multi-sensor extensions of immersive virtual environments*
- ❧ *Real-time 3D integration of real objects*
- ❧ *Design extensible application programming interfaces (APIs)*
- ❧ *Allow collaboration*

Mission

- ❧ *Build a prototype of a highly immersive projection and video acquisition environment for collaborative work*
- ❧ *Allow users to meet and collaborate in virtual worlds using advanced graphics, vision, computing, and networking techniques*
- ❧ *Development of advanced collaborative virtual reality applications*

The blue-c

- 🌀 The blue-c is a project to develop both technologies and applications.***
- 🌀 The blue-c team is composed of groups from ETH Zurich working on hardware, software, interface design, interaction, visual recognition and applications for the project.***

The blue-c

Key-features

- ∞ Immersive**
- ∞ Distributed and connected**
- ∞ Collaborative**
- ∞ Photo-realistic three-dimensional acquisition and rendering of users**
- ∞ No avatars**

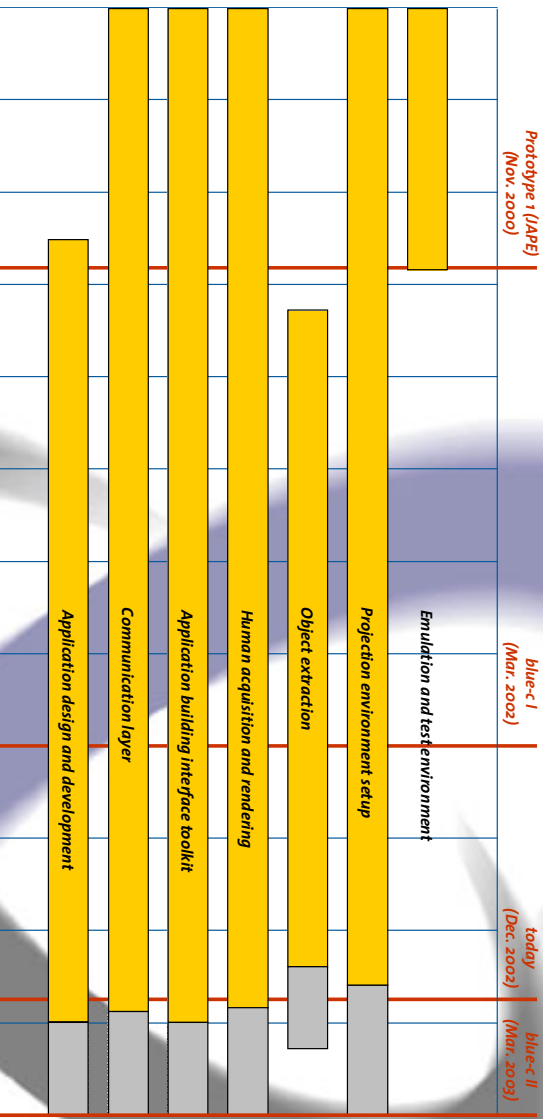
Applications

- ⌘ Architectural and engineering design***
- ⌘ Digital collaboration in product design and development***
- ⌘ Medical simulation***
- ⌘ Location-based entertainment***

The blue-c Team

- ❧ **Computer Graphics Laboratory**
Department of Computer Science - ETHZ
- ❧ **Center of Product Development**
Department of Mechanical and Process Engineering - ETHZ
- ❧ **Computer Aided Architectural Design Group**
Department of Architecture - ETHZ
- ❧ **Computer Vision Laboratory**
Department of Information Technology and
Electrical Engineering - ETHZ
- ❧ **MultiMedia Laboratory**
Department of Computer Science- University of Zurich

Project Timeline



Project Team @ ETHZ

	Computer Graphics Laboratory	Center for Product Development	Computer Aided Architectural Design	Computer Vision Group
Project Lead	Prof. M. Gross	Prof. M. Meier	Prof. L. Hovestadt	Prof. L. Van Gool
	E. Lamboray	Dr. A. Kunz	S. Lang	Dr. E. Koller-Meier
	M. Näf	C. Spagno	K. Miesusset	Dr. T. Svoboda
Team Members	S. Würmlin	S. Müller	K. Strehlike	R. Kehl
		Y. Parish	A. Vande Moere	

Ph.D. Overview

Groups	planned	realized
<i>Computer Graphics Laboratory</i>	3	3
<i>Center for Product Development</i>	2	3
<i>Computer Aided Architectural Design</i>	2	4
<i>Computer Vision Group</i>	1	1
Total	8	11

Own Investment

Groups	Salaries	Equipment	Total
Computer Graphics Laboratory	CHF 285K	CHF 50K	CHF 335K
Center for Product Development	CHF 35K	CHF 11K	CHF 46K
Computer Aided Architectual Design	CHF 216K	CHF 35K	CHF 251K
Computer Vision Group	CHF 125K	CHF 30K	CHF 155K
Total	CHF 661K	CHF 126K	CHF 787K

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Tactical Patent
**“Verfahren, Vorrichtung
und Gerät zur Erfassung von
Bilddaten”**

PCT/CH01/00383

Tactical Patent
**“Projektionsvorrichtung und
Verfahren zur Wiedergabe
und Erfassung von
Bilddaten”**

Nr. 2002 0436/02

Tactical Patent
**“System und Verfahren zum
Erzeugen von 3D-Bilddaten”**

Nr. 2002 1044/02

Computer Graphics Laboratory

Development responsibilities:

SOFTWARE development and programming:

- ❧ *3D human acquisition and rendering*
- ❧ *Application programming interface*
- ❧ *Multimedia networking and communication*

Center of Product Development

Development responsibilities:

HARDWARE development and installation :

- ❧ *Construction of the blue-c portal*
- ❧ *Projection screens*
- ❧ *Stereo projection hardware*
- ❧ *Synchronization of components (electronics)*
- ❧ *Applications*

Computer Aided Architectural Design

Development responsibilities:

CONTENT

- 🌀 *Applications*
- 🌀 *Interface Design*
- 🌀 *Physical design of the blue-c*
- 🌀 *Webpage design and public relations*

Computer Vision Laboratory

Development Responsibilities:

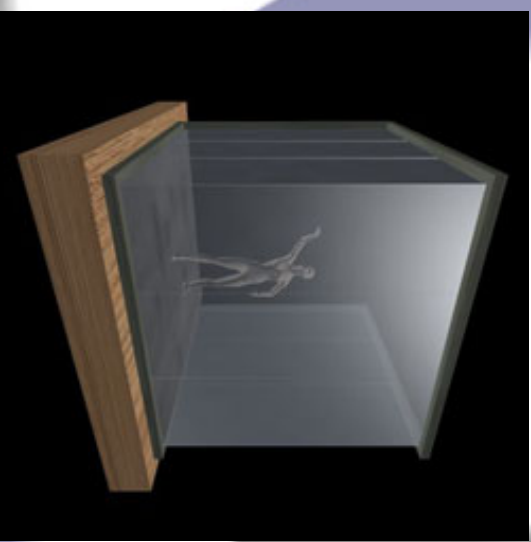
INTERACTION and RECOGNITION:

- ❧ *System calibration (cameras, illumination)*
- ❧ *Fore- / background segmentation*
- ❧ *Silhouette extraction*
- ❧ *3D human motion (gesture) analysis*

The blue-c

A collaborative immersive virtual environment

 ***Design***



Project Goals

Overview

- ❧ *Technology of a highly immersive projection and video acquisition environment of collaborative work*
- ❧ *Allow user to meet and collaborate in distributed virtual worlds*
- ❧ *Development of collaborative virtual reality prototype and applications*

Goals Phase I

- ❏ *Initial prototype design and construction of a three-sided, single-user collaborative virtual environment*
- ❏ *Build and connect two prototypes together (ETH-Zentrum, ETH-Hönggerberg)*
- ❏ *Real-time 3D acquisition and composition of real humans in virtual environments*
- ❏ *Navigation interface and protocols*
- ❏ *Communication interface and protocols (collaboration)*
- ❏ *Stereo projection and local (real-time) 3D rendering*
- ❏ *Video and audio transmission via network*
- ❏ *3D head tracking and 3D interaction devices*
- ❏ *Selected applications: architecture, medicine, product design*

Phase I

Milestones

- 🌀 Summer 2001
 - First blue-c portal completed
 - Located at the RZ building at ETH Zentrum
 - Comprises most hardware components of the final system
 - Four patents filed
- 🌀 Autumn 2002 (anticipated)
 - One stand-alone blue-c system including all hardware and software components
- 🌀 Spring 2003 (anticipated)
 - Link two blue-c systems
 - Located at ETH Zentrum and ETH Honggerberg



Technology

Hardware and Software

The blue-c

First blue-c portal



Components

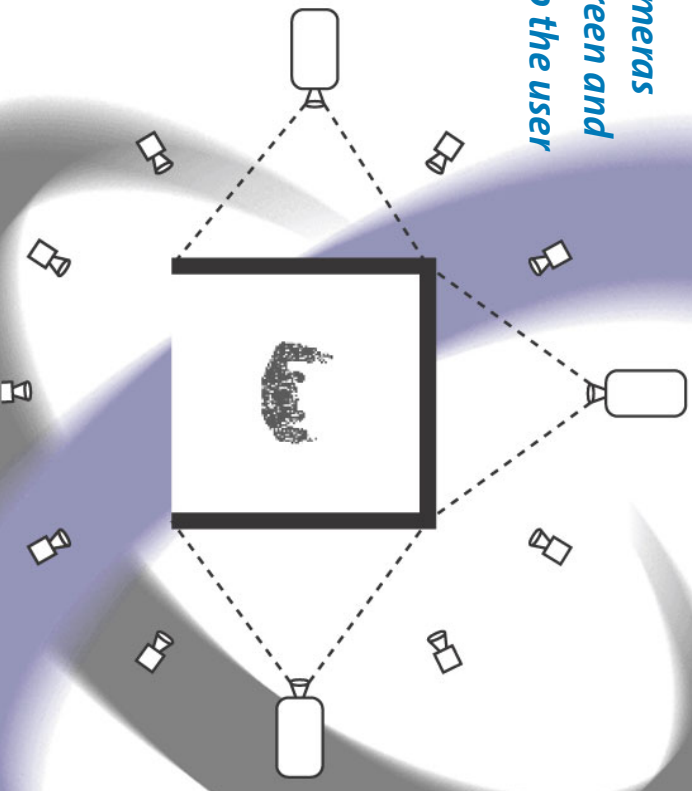
Hardware

- ❧ *Multi-pipe projection (three stereo projection units)*
- ❧ *Rendering Server*
- ❧ *Tracking*
- ❧ *Spatial audio and speech*
- ❧ *“Active” projection screens*
- ❧ *Active illumination (strobes)*
- ❧ *Multi-camera video acquisition (16 cameras)*
- ❧ *3d video stream processing (PC cluster)*

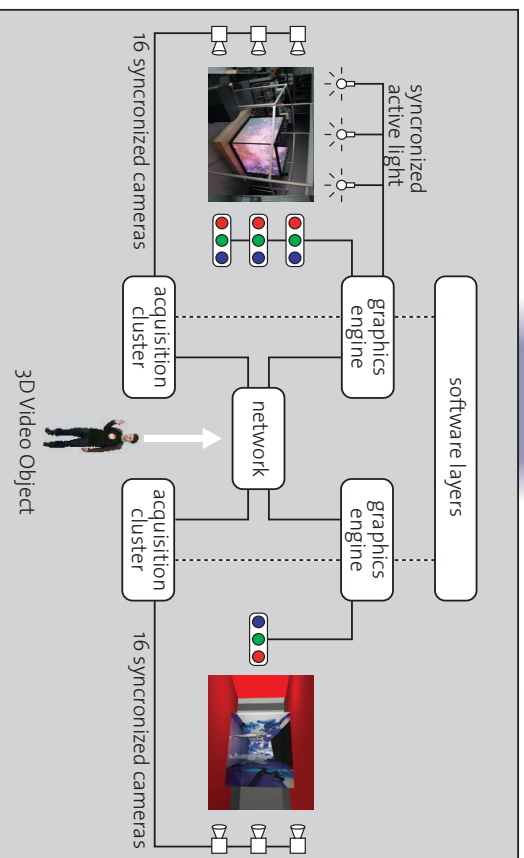
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Basic idea

Projectors and cameras are behind the screen and thus not visible to the user

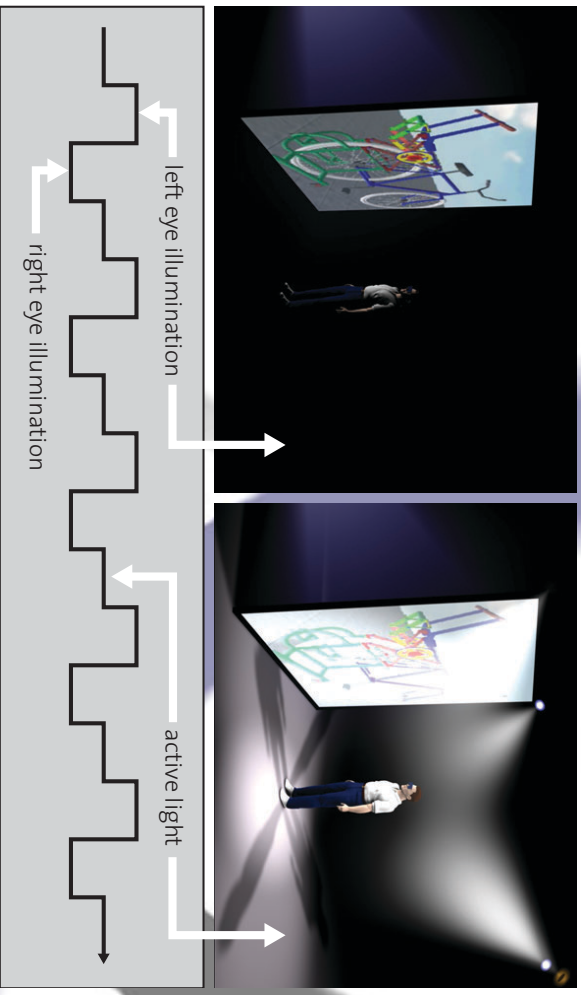


System Setup

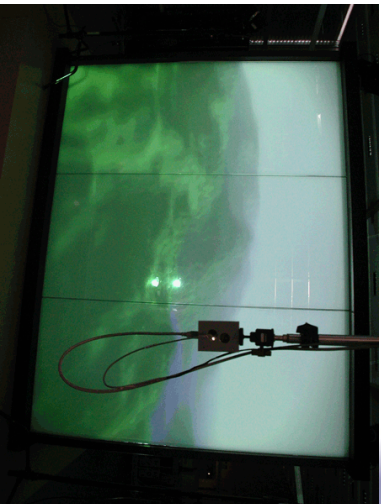


Active Illumination

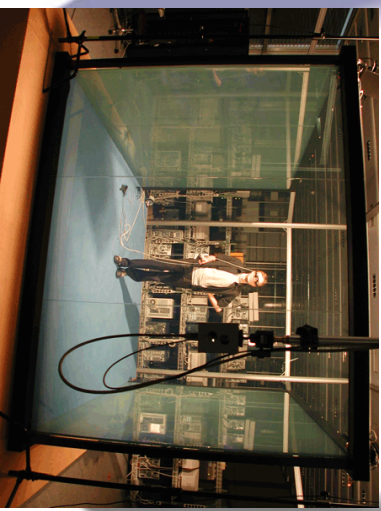
Synchronization: cameras, projectors, lights, screens



Shuttered walls and synchronized cameras



walls **opaque** –
no acquisition, projection



walls **transparent** –
acquisition, no projection

Components

Software

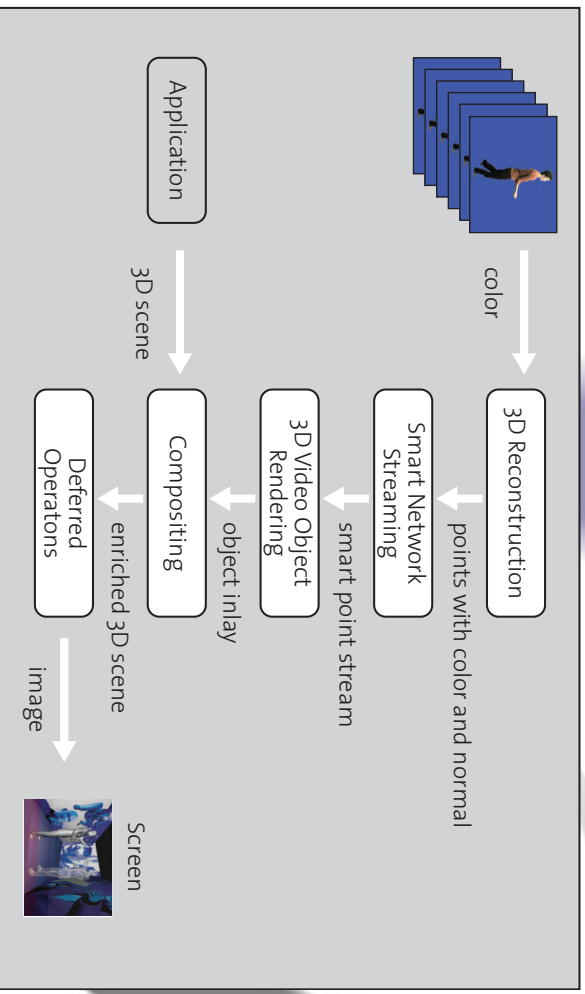
- ↳ *Human 3D acquisition and reconstruction*
 - ↳ *Segmentation*
 - ↳ *3D reconstruction incl. system calibration*
 - ↳ *Point based (3D video) rendering and compositing*
- ↳ *Networking and communication*
 - ↳ *Event synchronization*
 - ↳ *Multimedia streaming*
- ↳ *Application programming interface*
 - ↳ *Distributed scene graph*
 - ↳ *Human integration*

Human 3D Acquisition

- ⌘ Acquisition of the user
 - ↳ Up to 16 cameras
- ⌘ Real-time 3D reconstruction
- ⌘ Progressive compression and transmission
- ⌘ Real-time rendering
- ⌘ Compositing
- ⌘ Deferred operations, e.g. re-shading

Human 3D Acquisition

Real-time 3D acquisition pipeline



Human 3D Acquisition

Acquisition setups

- Small-scale setups for real-time video acquisition and reconstruction
- Based on 4-6 firewire NTSC cameras
- Linux cluster for processing and rendering (6-8 nodes)
- CORBA communication services



acquisition setup 1



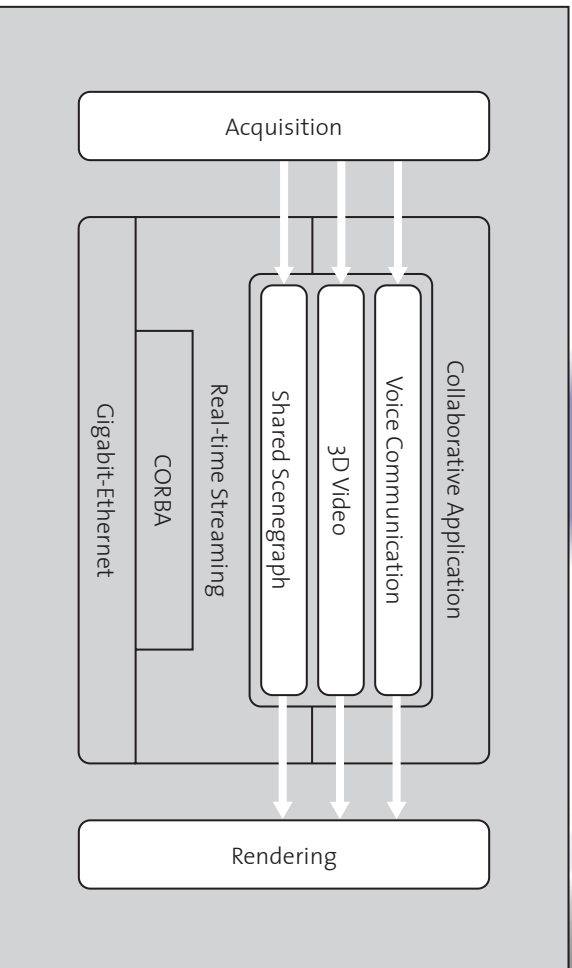
acquisition setup 2

Silhouette Extraction

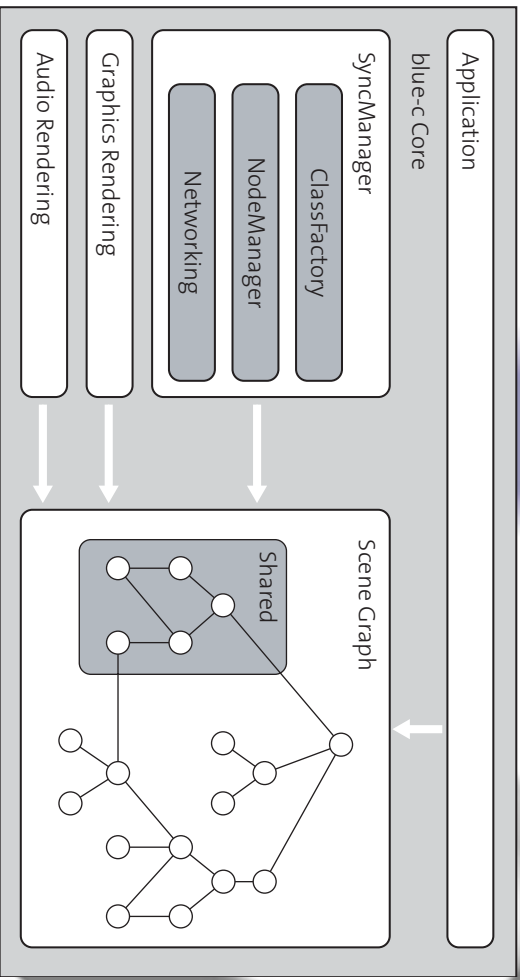
- ✧ *Silhouette extraction from pre-segmented image*
- ✧ *coarse to fine - multi-scale approach*
- ✧ *Can be used to trade-off visual quality and performance*



Newtworking and Communication



Application Programming Interface



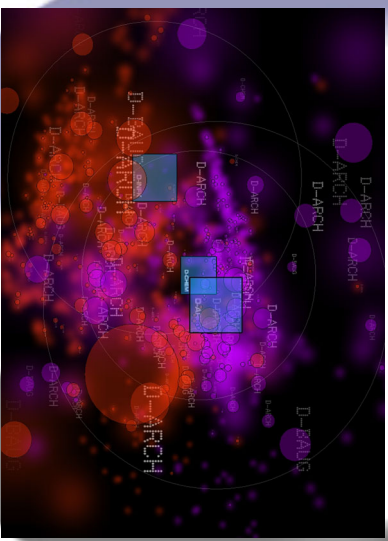
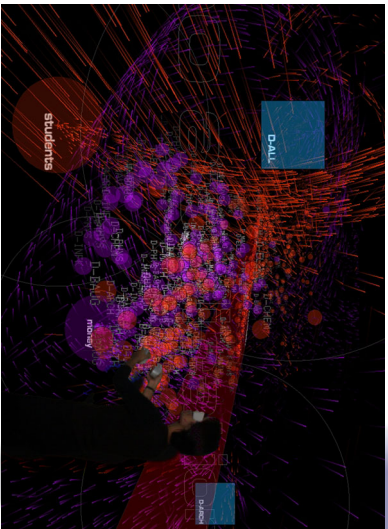
Applications

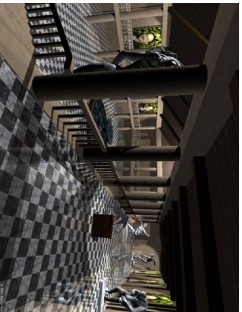


Fashion Show



Infoticles





Museum



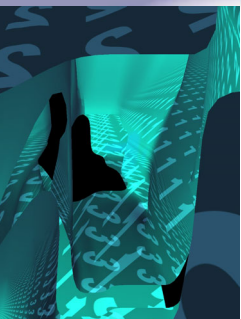
Chess



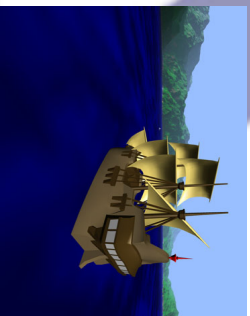
Painter



Ego Viewer



Subspaces



Landscape

Paper and Poster

- ❏ Gross, Kunz, Meier, and Staadt.: „**The Blue-C: Integrating Real Humans into a Networked Immersive Environment.**” *Proceedings of ACM Collaborative Virtual Environments 2000*
- ❏ Gross, M.; Kunz, A.; Meier, M.; Staadt, O.: “**The Blue-C: Integrating Real Humans into a Networked Immersive Environment**”; *CVE Conference 2000*
- ❏ Lamboray, Naef, Wuermelin, Staadt, and Gross. “**A CORBA-Based Distributed Virtual Reality Platform.**” *IEEE Middleware 2001, IEEE Distributed Systems Online, Vol. 2, No. 7, 2001*
- ❏ Staadt, Naef, Lamboray, and Wuermelin. “**JAPE: A Prototyping System for Collaborative Virtual Environments.**” *Proceedings of Eurographics 2001.*
- ❏ Gross and Staadt. “**The blue-c Project.**” *ERCIIM News No. 44, 2001.*
- ❏ Kunz, A.; Spagno, C.: “**Modified Shutter Glasses for Projection and Picture Acquisition in Virtual Environments**”; *IEEE Virtual Reality 2001 Conference; March 13.-17. 2001; Yokohama, Japan*
- ❏ Kunz, A.; Spagno, C.: “**Novel Shutter Glass Control for Simultaneous Projection and Picture Acquisition**” *Immersive Projection Technology and Virtual Environments 2001, pp. 257-266; May, 16-18 2001; Stuttgart (Germany); Springer-Verlag Wien/New York*

Paper and Poster

- ❏ Kunz, A.; Spagno, C.: “**Simultaneous Projection and Picture Acquisition for a Distributed Collaborative Environment**”; IEEE Virtual Reality 2002 Conference, March 24.-28. 2002, Orlando, Florida, USA
- ❏ Kunz, A.; Spagno, Ch.: “**Technical System for Collaborative Work**”; Virtual Environments 2002 - Eurographics Workshop in cooperation with ACM Siggraph; Mai 30. - 31. 2002; Barcelona, Spain
- ❏ Andrew Vande Moere, “**Infoticles: Information Modeling in Immersive Environments**”, IVO2, 6th International Conference on Information Visualisation, London, England, July 2002
- ❏ Andrew Vande Moere, “**Interactive Poster: Immersive Information Modeling using Particles**”, Poster Compendium of IEEE Symposium on Information Visualisation, October 2002, Boston, USA
- ❏ Naef, M.; Stadt, O.; Gross, M.: “**Spatialized Audio Rendering for Immersive Virtual Environments**”; Proceedings of ACM VRST 2002, November 11.-13. 2002, Hong Kong
- ❏ Wuermelin, S.; Lamboray, E.; Stadt, O. G.; Gross, M. H.: “**3D Video Recorder**”; Proceedings of Pacific Graphics’02, IEEE Computer Society Press, October 09.-11. 2002, Beijing, China
- ❏ Kunz, A.; Spagno, Ch.: “**VR zur Unterstuetzung des kollaborativen Arbeitens**”; 13. Symposium Design for X, November 10.-11. 2002, Neukirchen

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