08231 Abstracts Collection

Virtual Realities

— Dagstuhl Seminar —

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Abstract. From 1st to 6th June 2008, the Dagstuhl Seminar 08231 "Virtual Realities" was held in the International Conference and Research Center (IBFI), Schloss Dagstuhl.

Virtual Reality (VR) is a multidisciplinary area of research aimed at interactive human-computer mediated simulations of artificial environments. Typical applications include simulation, training, scientific visualization, and entertainment. An important aspect of VR-based systems is the stimulation of the human senses – typically sight, sound, and touch – such that a user feels a sense of presence (or immersion) in the virtual environment. Different applications require different levels of presence, with corresponding levels of realism, sensory immersion, and spatiotemporal interactive fidelity.

During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. Links to extended abstracts or full papers are provided, if available.

Keywords. Virtual reality, augmented reality, 3d user interfaces, motion tracking, haptics

1 Summary

During the week of June 1-6, 2008, the Schloss Dagstuhl - Leibniz Center for Informatics held a first-of-its-kind seminar in the area of Virtual Reality. Being the first seminar in this area, both the organizers and the participants were not completely sure what to expect from this event beforehand. In retrospect we rate this Dagstuhl seminar as a great success.

First we succeeded in bringing together a good mix of leading researchers and promising younger scientists. In total 50 researchers from 11 different countries participated in the seminar; nine of them were women. The attendees were

mostly affiliated with universities, with a few coming from research institutes (e. g. MPI, Fraunhofer) or industry.

The format of the seminar sessions changed during the week. Based on responses from the participants, the organizers tried to adapt to evolving needs for more discussions or lectures. One idea that turned out to be very fruitful was to concentrate the discussion towards the end of each session. I. e. the talks were presented without the usual question part. Instead at the end of the session all speakers took a seat in front of the audience and answered questions in panel style. This format allowed questions to bridge between the talks, and stirred very lively discussions. These were considered to be so productive that the lengths of the talks had to be reduced in order to free up time.

On Wednesday morning the whole group met for a "grand challenge discussion." Based on the results of this session different topics were defined for further discussion in parallel sessions. On Thursday afternoon the group split up to work on the following issues:

- Latency
- Augmented Reality
- Experience Design
- Virtual Humans
- Perception.

Since these themes were selected by a vote from a larger list, it is an indication that these topics were considered some of the most important in VR.

Latency is recognized by VR researchers as a topic that is important but under-reported in the field. The group identified the main sources of latency: tracking and other input devices, interface buffering, network delays, device driver and operating system overheads, application simulation time, rendering (software and hardware), and display devices. In a typical system, the end-to-end latency is the sum of these. It is this end-to-end timing that was identified as the key measurement for comparing different systems, and for understanding the impact of varying levels of latency on task performance. There is also a need to measure the latencies in the contributing components.

The discussion of existing methods for measuring and reporting end-to-end latency made clear that these methods will have to be straightforward to use if they are to be adopted widely by the VR researchers and practitioners. Two variants were proposed: one for HMDs and the other for screen/projector-based systems, and the group agreed to further develop these for dissemination. More generally, it was agreed that there is an urgent need for a 'field guide to latency'.

In Augmented Reality the observer's view of a real scene is enhanced by virtual objects. Examples include to blend in repair instructions into the field of view of a car mechanic, or to project MRI data onto a patient during a surgery. Obviously, AR requires accurate tracking of the user. In moving environments it might be necessary to combine different kind of tracking devices in order to avoid situations where the tracked markers are lost. To make use of the full potential of AR it is important to install AR infrastructure not only in laboratories but

in usual environments (e.g. offices). In this context the concept of AR-ready buildings was discussed.

The group that worked on Experience Design focused on the creative use of existing VR equipment to create compelling experiences. This extremely fruitful discussion took advantage from the different views of engineers, psychologists and practitioners in multimedia design.

The discussion made clear that not only the technical possibilities but also the script of the presentation has a strong effect on the experience made by the user. Visitors of virtual worlds are usually more impressed when technical explanations (how it is done) are not given in advance. Depending on the application it can also be advantageous to leave certain details to the imagination of the observer. Also, the element of surprise is an effective means for getting the observer involved in the virtual environment.

An extremely important research topic in VR is that of virtual humans. Similar to the Turing test of AI, the goal is here to design the appearance of virtual humans and their interaction with the user so life-like that emotions are invoked similar to those in inter-human interactions. One application presented in Dagstuhl was a training environment for medical doctors. To improve their interaction with patients a virtual environment has been created in which difficult situations between doctors and patients can be simulated.

In the perception group it was discussed how recent results from perceptual psychology could be used for the design of intuitive 3D human computer interfaces. Another issue of this group was the problem of simulation sickness, and the question of how the length of time humans can be exposed to virtual environments can be extended.

Overall, the Dagstuhl seminar was the ideal event to define and discuss key topics in current research in VR, and to initiate new research collaborations. We plan to publish a book comprising research results presented in Dagstuhl, along with essays inspired by the work of the discussion groups.

2   Program

Monday

0900-1030 Introduction − Organizers

- Welcome
- Self-Introduction

1030-1050 Coffee Break
1050-1210 Ubiquitous AR − Wolfgang Broll, Chair

- Gudrun Klinker, TU München
  Ubiquitous Augmented Reality
- Mark Billinghurst, Univ. of Canterbury
  Crossing Boundaries: Towards Ubiquitous VR and AR
- Discussions

1215-1400 Lunch
1400-1530 Motion capturing − Greg Welch, Chair

- Andreas Weber, Univ. of Bonn
  Tracking of human body motions using very few inertial sensors
- Bernhardt Jung, TU Bergakademie Freiberg
  VR-based Character animation with Action Capture
- Bodo Rodenhahn, MPI Saarbrücken
  Motion Capture & Animation of MMI

1530-1600 Coffee Break
1600-1730 VR systems design − Henry Fuchs, Chair

- Robert Lindemann, Worcester Polytechnic Inst.
  Endowed Virtual Objects
- Roland Blach, IAO Stuttgart
  Asynchronicity in interactive real-time engines
- Marc Latoschik, Univ. of Paderborn
  Design & Development of Intelligent interactive 3D graphics systems
- Discussions

Tuesday

0900 Interaction (15 minutes per talk) – Rob Lindeman, Chair

- Wolfgang Stuerzlinger, York University - Toronto
  Next Generation 3D Interaction Techniques
- Yoshifumi Kitamura, Osaka University
  Biologically inspired 3D User Interface
- Steffi Beckhaus, Universitaet Hamburg
  Chair and Shape-Based Interaction

1100 Virtual Humans (15 minutes per talk) – Marc Latoschik, Chair

- Benjamin Lok, University of Florida
  Virtual Human Systems for Interpersonal Interaction Education
- Betty Mohler, MPI fuer biologische Kybernetik - Tuebingen
  MPI Research and Avatars Walking in Virtual Reality

1345 Applications (15 minutes per talk) – Makoto Sato, Chair

- Stephan Olbrich, Universitaet Dusseldorf
  Scalable simulation and visualization – Challenges in and solutions for massivelyparallel computing and networked virtual reality applications
- Simon Richir, ENSAM Presence & Innovation Laboratory - Laval
  VR for engineering design & engineering design of VR systems
- Carolina Cruz Neira, LITE - Lafayette
  LITE: A New Paradigm to Integrate Research, Tech Transfer, and Production
- Mark Mine, Walt Disney Imagineering
  VR Tools for Disney Theme Park Design

1600 Presence/Perception (15 minutes per talk) – Steffi Beckhaus, Chair

- Heather Jenkin, York University - Toronto
  Which way is UP? Studies in spatial disorientation and virtual reality
- Mary Whitton, University of North Carolina- Chapel Hill
  Recent work and thoughts: Redirected walking, walking-in-place, and using logsof behaviors
- Mel Slater, TU of Catalonia - Barcelona
  Global Illumination and Presence in Virtual Reality
- Vicki Interrante
  The Effect of Self-Representation on Spatial Perception in Immersive Virtual Environments

2000 Breakout discussion: Latency

Wednesday

0830 Multimodal (10 minutes per talk) – Robert van Liere, Chair

- Ramesh Raskar, MIT - Cambridge
  Second Skin: Wearable fabric for Bio-I/O platform
- Makoto Sato, Tokyo Inst. of Technology
  Recent R&D of haptic systems - SPIDAR -
- Sabine Coquillart, INRIA Rhone-Alpes
  A First Person Visuo-Haptic Environment
- Torsten Kuhlen, RWTH Aachen
  Forget about Acoustics!?

1000 Computer Vision (10 minutes per talk) – Bodo Rosenhahn, Chair

- Jan-Michael Frahm, University of North Carolina- Chapel Hill
  Location from cameras
- Michael R. M. Jenkin, York University - Toronto
  3D Crime Scene Acquisition, Representation and Analysis

1100 Grand Challenge Discussion, Ramesh Raskar, Chair

Thursday

0830-0945 Displays (15 minutes per talk) − Bernd Fröhlich, Chair

- Hans Hagen, TU Kaiserslautern
  Large Display Environments and Acoustic VR
- Tobias Hollerer, Univ. California - Santa Barbara
  Inside, Outside, and Through the Screen - Pursuing Novel Display and Interaction Technologies
- Dieter Fellner, Fraunhofer IGD, Darmstadt
  TBA

0945-1030 Rendering (15 minutes per talk) − Haruo Takemura, Chair

- Robert van Liere, CWI - Amsterdam
  Smooth motion and crosstalk reduction: how to evaluate the user experience?
- Bernd Froehlich, Bauhaus-Universitaet Weimar
  Multi-Frame-Rate Rendering and Beyond

1030-1100 Break
1100-1215 Telecollab/Telepresence (15 minutes per talk) − Mel Slater, Chair

- Anthony Steed, University College London
  Telecollabration across display types
- Greg Welch, University of North Carolina- Chapel Hill
  Technologies for Telepresence Over Time, Space, and Imagination
- Henry Fuchs, University of North Carolina- Chapel Hill
  Building Compelling Tele-immersion Systems

1215-1400 Lunch
1400-1530 Augmented Reality (15 minutes per talk) − Mark Billinghurst, Chair

- Steven Feiner, Columbia University
  Toward Situated Visualization through Augmented Reality
- Dieter Schmalstieg, TU Graz
  Augmented Reality 2.0.
- Wolfgang Broll, Fraunhofer Institut FIT - St. Augustin
  Augmented Life
- Haruo Takemura, Osaka University
  Ambient Information Society and VR/MR

1530-1600 Break
1600-1800 Break-Out Discussions

Friday

0900-1015 Interaction (15 minutes per talk) – Tobias Hollerer, Chair

- Gabriel Zachmann, TU Clausthal
  Technologies for Making the Hand Usable as an Interaction Device in VR
- Carlos Andujar, TU of Catalonia - Barcelona
  Improving 3D Selection in Immersive Environments through Expanding Targets
- Guido Brunnett, TU Chemnitz
  VR Prototyping of Shoes

1015-1030 Break
1030-1200 Closing Discussion
1200 Adjourn

3   Abstract Collection

Improving 3D Selection in Immersive Environments through Expanding Targets

Carlos Andujar (TU of Catalonia - Barcelona, ES)

The application of Fitts' law to HCI has lead to a number of successful techniques to improve virtual pointing performance. Fitts' law indicates three possible approaches for optimization: reducing the distance to the target, increasing its size, or changing the control-display ratio.

In this talk we address the extension of 2D pointing facilitation techniques to 3D object selection. We focus on which problems must be faced when adapting such techniques to 3D interaction on VR applications, and we suggest two strategies to adapt the expanding targets approach to the 3D realm, either by dynamically scaling potential targets or by using depth-sorting to guarantee that potential targets appear completely unoccluded.

We also present preliminary experiments to evaluate both strategies in 3D selection tasks with multiple targets at varying densities.

Joint work of: Andujar, Carlos; Argelaguet, Ferran

Chair- and Shape-based Interaction

Steffi Beckhaus (Universität Hamburg, DE)

Truly engaging the user into the experience of a virtual world or an application remains a challenge in VR. Providing full sensory information plus putting the user in control is complex and technologically not solved. Thus, purposefully integrating reality into the virtual environment may, at least for now, relieve some of the current deficiencies, This talk presents two interaction techniques which not only control parameters in the virtual environments (VEs), but also feature some implicit sensory feedback to the user.

The first is the ChairIO, a chair-based interface which has proven to be highly intuitive for navigation in VEs even to novice users. It allows for precise control of directional and orientational motion, but also features bouncing of the chair. Users engage into moving the chair and enjoy, at the same time, the feedback of their position and a feeling of being integrated into the environment. The talk presents several mappings used in games ranging from navigation to bouncing for flapping wings of a bird.

The second is GranulatSynthese, an audio-visual-haptic interface using vinyl granules on a rear-projected table. The interface distinguishes between granule-covered areas of the table and the shape, size and position of open space areas, which can be used to control the application - shape-based interaction. The

metaphor, very much like playing in a sandbox, is very accessible and the granules provide a pleasant haptic, tactile, and audio feedback.

Both interfaces are highly intuitive to control and offer users a rich and accessible way of getting into the flow of the application. We, however, not only need to provide people with intuitive, engaging user interfaces, but also need to design the experience itself. In my opinion, this is mostly not done and is one of the current challenges for the VR community.

Crossing Boundaries: Towards Ubiquitous Virtual and Augmented Reality

Mark Billinghurst (University of Canterbury - Christchurch, NZ)

Invisible computing is one of the goals of Human Computer Interaction - where interfaces are so transparent that they do not get in the way of the users main task. Over a decade ago Rekimoto discussed how invisible computing could be achieved through Virtual Reality, Augmented Reality or Ubiquitous Computing. In this presentation we discuss how interesting research can be done at the boundary of these three areas, and give an overview of Ubiquitous Virtual Reality which combines elements from all of these technologies. Developments in Virtual Reality, Augmented Reality and Ubiquitous Computers have advanced to the point where robust Ubiquitous VR and AR interfaces can be produced. In this presentation we will review work in the area and discuss some of the interesting research topics that could be explored.

Synchronicity in interactive real-time engines

Roland Blach (FhG IAO - Stuttgart, DE)

In interactive real-time engines which drive various hardware configurations found in VR/AR/MR, many software components are integrated. One of the strengths of these engines is found in these specific integration capabilities. I am interested in decoupling these components in terms of time and synchronization. A lot of research has been done for distributed and collaborative systems mainly to overcome network bottlenecks. My main questions are: if also local systems can benefit from these approaches (i think so yes), if and how they have to be adapted and how to generalize this approach to be an integral part of an engine architecture.

Joint work of: Blach, Roland; Matthias Bues

Augmented Life

Wolfgang Broll (Fraunhofer Institut FIT - St. Augustin, DE)

Throughout the last 10 to 15 years Virtual Reality (VR) has significantly influenced and improved several areas, to mention production, prototyping, and exploration among others. It moved out of the labs and has been adopted by industry. However, the majority of VR installations are found in large companies due to the rather large space and investment required. Desktop VR on the other hand, has been around for much longer and even distributed or collaborative virtual environments (DVEs/CVEs) were already available 10 years ago. While they used to lead a wallflower existence, this has changed with the increasing popularity of the Second Life online virtual environment. Becoming part of the Web 2.0 movement, companies, organizations, and individuals discoverd VR as new media to contribute and express themselves.

But what about Augmented Reality (AR)? While providing a much more general and by that wider application area, AR still seems to suffer from basic technological unsufficiencies, providing more promises and expectations than solutions. This talk will present recent trends in AR and dicuss forthcoming developments in AR applications. It will show, how future AR developments may have a significant impact on our daily life, regarding our use of ICT, and the recognition of and the interaction with our environment as well as with other people.

Keywords: Augmented Reality, Mixed Reality, ubiquitous computing, pervasive computing

VR-based Prototyping of Shoes

Guido Brunnett (TU Chemnitz, DE)

In the shoe industry decisions about which shoes are going to be manufactured are based on physical protypes. The creation of these protypes is time consuming and restrictive to the design process because there is no way to create fast variants. In this talk we report about on-going work towards a VR-based system for the prototyping of shoes. The principle challenge in this context is the design of the user interface. The shoe designers consider themselves as artists and they are very reluctant to change their tools. We will show that VR technology enables us to design a user interface that mimics the conventional tools of the designers and enhances their creative potential of. To reduce the burden of calibrating the input devices a method for automatic calibration of any such devices has been developed.

Keywords: Virtual Reality, tracking, Shoe design, automatic calibration

Joint work of: Brunnett, Guido; Rusdorf, Stephan; Kühnert, Tom

A First Person Visuo-Haptic Environment

Sabine Coquillart (INRIA Rhône-Alpes, FR)

In real life, most of the tasks we perform throughout the day are first person tasks. Shouldn't these same tasks be realized from a first person point of view in virtual reality ? This paper presents the Stringed Haptic Workbench, a new First Person Visuo-Haptic Environment based on a two-screen workbench. This virtual environment is enriched with a Stringed Haptic Interface. Several applications have been developed using this new environment. They take advantage of the first person visualization and haptic manipulation. xx

Keywords: Virtual reality, 6dof force feedback, projection-based virtual environments, co-location, virtual prototyping, scientific visualization

LITE: A New Paradigm to Integrate Research, Tech Transfer, and Production

Carolina Cruz Neira (LITE - Lafayette, US)

The Louisiana Immersive Technologies Enterprise (LITE) was created in September 2006 as an economic development driver for the state of Louisiana. LITE brings together academic research, technology transfer, and commercial services under a unique combination of visualization, high-performance computing, and advanced networks.

The integration of immersive visualization, high performance computing, and advanced networks enables a wide range of synergistic activities involving teams of faculty, scientist, students, industry practitioners, and government researchers. Together, these teams address applied research problems in many disciplines developing new visualization and computing models as well as deploying innovative software technologies. Examples of such projects are the real-time integration of intense supercomputing simulations with immersive visualization to provide researchers a dynamic environment to explore interactively their problem domain, and the ability to display and correlate large amounts of data though the use of multidimensional visualizations.

LITE is a leading institution in the area of the integration of visualization and computational simulations, making its facility available to research and applied groups from around the nation. LITE's wide range of projects are supported through collaborations with many agencies: Department of Energy, National Science Foundation, Army Research Lab, Office of Navy Research, as well as private funding through its collaborations and partnerships with industry.

LITE leverages the State of Louisiana Technical Infrastructure by being one the Louisiana Optical Network Initiative (LONI) nodes and having strong collaborations with most of the other universities in the state. For example, LITE is one of the lead partners in the NSF-funded Cybertools initiative, which brings

together leading researchers in computational science from across Louisiana to develop an advanced cyberinfrastructure which provides the software tools to leverage the LONI resources for scientific discovery. LITE's research and technology is also a key player in the University of Louisiana's National Incident Management Systems and Advanced Technologies (NIMSAT), focusing on work related to cyberinfrastructure for homeland security issues.

Keywords: Virtual reality, applied research, applications, technology transfer

Toward Situated Visualization through Augmented Reality

Steven Feiner (Columbia University, US)

As computation, sensing and display become more mobile and distributed, the locus of interaction shifts to the environment and objects we encounter in the environment. This shift changes how we view the world and our expectations about interacting with our surroundings, creating the opportunity for *situated visualization*—visually representing data in its spatial and semantic context. Examples include visualizing information about a plant species near a physical specimen or mapping relevant urban GIS data directly onto the user's view of the city through augmented reality. Situated visualization provides increased opportunities to discover patterns in and gain insight into the surrounding environment. In this paper, we introduce situated visualization, review related work, describe several research projects that illustrate important characteristics of situated visualization, and discuss research issues and challenges for the future.

Keywords: Augmented Reality, situated visualization, information visualization, mobile computing

Joint work of: White, Sean; Feiner, Steven

Tomorrow's Technologies for Humans - Seen through the VR/AR glasses

Dieter Fellner (TU Darmstadt, DE)

In my presentation I have addressed the area of Cultural Heritage - more precisely the idea of the "museum of the future" proposed by Otto Neurath. According to his vision, cultural artefacts/the "museum" should be brought to locations where the people are.

In the context of this scenario, I argue that new VR/AR technologies are pushing this idea to a new level: VR/AR worlds are entering the main stream; mobile phones are getting mature and start replacing personal computers; immersive technology is becoming usable and affordable and new interaction paradigms

are making new technologies accessible. Some examples from our labs are concluding the presentation: the "AR Telescope", content-aware visualization, the "Cyber Saw", are examples for native interface approaches while the Brain-Computer Interface (BCI) developed by our partners at TU Graz is still in the area of radical innovation. Finally, the issue of affordability is being addressed with the "3D-Cube" and the "DAVE" , developed together with Digital Image, and the "Multi-Touch Table" and the "HEyewall2", both developed at IGD.

Dieter Fellner Dagstuhl, 6.06.2008

Keywords: Immersive technology , AR Telescope, Cyber Saw

Location from cameras

Jan-Michael Frahm (University of North Carolina- Chapel Hill, US)

Recent advandages in computer vision allow for real-time scene reconstruction from street side video. The generated large scale models are providing rich information for augmented reality systems. The talk introduces techniques for creating and using these models to assist in location recognition for cameras for example cell phone cameras.

Keywords: Cameras, structure from motion, location recognition

Multi-Frame-Rate Rendering and Beyond

Bernd Fröhlich (Bauhaus-Universität Weimar, DE)

This talk will briefly introduce multi-frame-rate rendering and related techniques to deal with artefacts of this technique. Further research opportunities and system concepts will be discussed.

Building Compelling Tele-immersion Systems

Henry Fuchs (University of North Carolina- Chapel Hill, US)

Tele-immersion systems that give a compelling sense of shared presence to distant users have been a goal of system builders for decades. This talk will highlight several systems built in the past decade that promised much, and delivered on some of their promises: the (USA) National Tele-immersion Initiative, coordinated by VR pioneer Jaron Lanier and built by a team of several institutions in 1997-2000; and system built 2001-2004 by UNC, UPenn and Pittsburgh Supercomputing Institute; and Blue-C, built by ETH Zurich in 2002.

Each system's goals and design choices will be examined and analyzed. For example, certain goals may have imposed almost impossible-to-meet constraints — large area stereo camera acquisition co-located with large stereo display. The analysis will be followed by speculation on ways a system built now, almost decade later, may exhibit significantly improvements.

Large Display Environments and Acoustic VR

Hans Hagen (TU Kaiserslautern, DE)

Today, the amount of unstructured, multidimensional information is becoming more and more complex and overwhelming. One promising approach to face these problems is the making use of large displays. But what is it that makes large screens so captivating and how do we use them effectively? For the latter, we need to understand the advantages and reduce the disadvantages of this large medium.

Common setups of large displays are LCD-based two-dimensional high-resolution tiled display walls or projector-based stereoscopic environments.

LCD-based systems combine high-resolution with reasonable costs. Nevertheless, LCD-based displays have to cope with the bezels of monitors causing discontinuities in the visualizations. Conventional approaches either ignore the bezels and accept deformations or compensate them at the cost of losing pixel information. However, both approaches are often not acceptable depending on the user and the application. The immersive effect of large displays is even stronger when using a stereoscopic representation of information. However, the technical limitations of such 3D projective systems result in a loss of detail and a bad readability of textual information and fine details.

We present two novel approaches to better face the mentioned disadvantages. Both approaches have in common that they implement a kind of focus+context screen by bringing an additional projector into a common large display environment. In the 2D hi-res case, our concept adds a low-res context to the details presented on the tiled wall, thereby removing discontinuities as well as the usual loss of information. In the 3D case, we add a high resolution 2D focus area to the 3D overview, resulting in improved details, brightness and color.

This concepts will be demonstrated at an acoustic VR-application

Keywords: Large displays-acoustics-VR/AR

Joint work of: Hagen, Hans; Ebert, Achim

Inside, Outside, and Through the Screen - Pursuing Novel Display and Interaction Technologies

Tobias Hollerer (Univ. California - Santa Barbara, US)

Personal computing and the user interfaces that define our computer experiences are in transition. While most office computing is locked in to the traditional 2D Desktop paradigm, we are witnessing several developments of change in personal and mobile computing: the personal desktop is experiencing a 3D graphics makeover, cameras have become commonplace communication and input devices for a lively web 2.0 community, and mobile platforms with innovative interfaces

are entering the market. Newly established computing practice and patterns suggest several amendments to the original vision of ubiquitous computing.

On the other hand: It's 2008 and I still don't have a Holodeck in my home. I only use AR interfaces in my research, but not for daily tasks.

What will it take to push our research from the laboratory to general adoption? We use the term "Anywhere Augmentation" to describe our agenda to make augmented reality (AR) overlays readily and directly available in any situation and location. Graphical annotations can be viewed and placed through optical see-through glasses or by using your phone, PDA, or tablet computer as a video-see-through lens. A key question is how to achieve robust spatial registration between the objects in the physical world and their AR annotations. Promising new approaches make use of computer vision in conjunction with various GIS data sources, which are becoming universally available, allowing mobile users to grow and browse a web of volunteered location-based information around them.

In terms of display technologies, we argue for renewed efforts in pursuing the ultimate display. The UCSB Allosphere is our platform and instrument of choice to make scientific progress in this area.

Latency in VEs – Does it matter?

Roger Hubbold (Manchester University, GB)

Latency in VEs is a topic that many implementors ignore. But the evidence is that latency exists in many hardware and software systems that is above the level at which task performance is adversely affected, according to research in perceptual and cognitive psychology. Perhaps VR researchers should pay more attention to this.

Keywords: Latency, virtual environments

Investigating the Effect of Self-Representation on Spatial Perception in Immersive Virtual Environments

Victoria Interrante (University of Minnesota, US)

To what extent, under what conditions, and why, might providing people with an avatar self-embodiment within a head mounted display based immersive virtual environment facilitate their ability to accurately judge egocentric distances within that environment? Previous studies over the past decade have found that under most common conditions, people tend to under-estimate egocentric distances in HMD-based immersive virtual environments relative to in the real world, and despite much investigation the factors that underlie this phenomenon remain poorly understood.

Recently, however, we have discovered some exceptional situations in which the typically found distance underestimation does not appear to occur with as

nearly great severity [1, 2], and this discovery has led us to critical new insights both into the possible roots of the problem and into potentially promising strategies to overcome it.

Specifically, we have found that people tend not to systematically underestimate egocentric distances in immersive virtual environments that are high-fidelity replicas of existing real environments that they have recently been in [1], and that the increased accuracy of their distance judgments in these cases is not due to their retaining a metrically-accurate memory of the recently-viewed environment [2]. These findings, and the findings of our other, as yet unpublished, previous experiments have led us to the conclusion that the essence of the problem is not in the the visual stimulus that is provided through the HMD, but in how that stimulus is interpreted by the viewer.

Our current theory is that we find evidence of what looks like distance compression because, due to the many uncertainties inherent in being immersed in a novel virtual environment, people hesitate, at least initially, to assume that they can act on the visual stimulus provided by the HMD in the same way as they would act on the equivalent visual stimulus obtained in the real world. After all, a view of a virtual environment is really just a picture placed in front of one's eyes. Without any other information to help guide its interpretation, it could be a picture taken from any arbitrary location in space, and its affordances are completely unknown. However, when a person is 'present' in a virtual environment, we hypothesize that they will then be able to confidently leverage all of the interpretive resources that are at their disposal under real world conditions, which will facilitate their willingness and ability to act on the visual stimulus provided by the HMD in the same was as they would an equivalent visual stimulus obtained in the known real world.

These insights led us to re-open the question of whether or not giving people an avatar self-representation in an immersive virtual environment might facilitate their ability to make accurate egocentric spatial judgments in that environment. While previous studies have shown that peoples' default ability to accurately judge egocentric distances in the real world is not impaired when they are prevented from looking down and viewing their bodies [3], we assert that it does not directly follow from this that providing people with a self-embodiment in an immersive virtual environment will not be beneficial. On the contrary, to the extent that providing people with an embodiment reduces the uncertainties inherent in the experience of the virtual environment, and enhances their sensation of presence in the virtual world, it could make a significant difference.

In this talk, I present the results of a between-subjects experiment in which people immersed in a novel HMD-based virtual environment either with or without an avatar self-representation are asked to make distance judgments via blind walking to randomly placed targets on the floor. We use low-overhead methods to locally re-size a pre-defined avatar model to roughly conform to each participant's individual body measurements, and a 12-camera Vicon MX40+ motion tracking system to dynamically update the position of the avatar according to the movements of the participant in real time. To facilitate the between-subjects

comparison, each participant's distance estimation accuracy in the virtual environment is measured relative to his or her baseline accuracy in a real world environment that corresponds exactly to the virtual model. Our results (so far) appear to indicate a significant enhancement in distance judgment accuracy among participants who experience the avatar, in comparison with participants who do not. However, many further questions remain, and my talk will conclude with a discussion of ideas about promising directions for future work on this question.

Keywords: Distance perception, architectural design

Joint work of: Interrante, Victoria; Anderson, Lee; Ries, Brian; Kaeding, Michael

Which way is UP? Studies in spatial disorientation and virtual reality

Heather Jenkin (York University - Toronto, CA)

A variety of mechanisms have been developed at York University to test perceptual uncertainty such as spatial disorientations that specifically have relevance to life in microgravity. Spatial disorientation occurs when cues from the vision and vestibular systems are incongruent.

The typical research question is "How are relative weightings of vision, body sense and gravity combined to determine the direction of up?"

Our work uses large-scale real worlds (The York Tumbling Room), large-scale virtual environments (Immersive Virtual environment at York: IVY), small-scale computer simulations using laptops and binocular HMDs. A variety of experiments will be discussed to show how these different research tools can be used to show the underlying factors involved in the basic perception of up.

Keywords: Spatial disorientation, sensory integration

3D Crime Scene Acquisition, Representation and Analysis

Michael R. M. Jenkin (York University - Toronto, CA)

Effective investigation of crime scenes involving chemical, biological, radiological or nuclear contamination requires the development of technologies that enable remote crime scene investigation. This presentation describes results from the C2SM project – a project whose goal is the development and field evaluation of technologies for real time data acquisition at CBRN crime scenes and fast recreation of such scenes as virtual environments with access to all of the multimodal data and heterogeneous evidence associated with the scene.

Keywords: VR application, crime scenes

See also: http:/www.cse.yorku.ca/∼jenkin/gio

VR-based Character Animation with Action Capture

Bernhard Jung (TU Bergakademie Freiberg, DE)

We are developing a VR-based method for character animation that extends conventional motion capture by additionally tracking the actor's interactions in a virtual environment. Rather than merely re-synthesizing the actor's movements, the goal is to replicate the actor's goal-directed behavior.

Following Arbib's equation action = movement + goal we call this approach Action Capture. For this, the VR user's movements and interactions are analyzed and transformed into high-level action representations and style models. As an advantage, captured actions can often be naturally applied to varying situations, avoiding re-targeting problems of motion capture. This talk will present several Machine Learning techniques we successfully applied within the action capture framework, particularly relating to the recognition and animation of realistic human grasping actions.

Keywords: Virtual Reality, Motion Capture, Machine Learning, Virtual Prototyping

Biologically inspired 3D User Interface

Yoshifumi Kitamura (Osaka University, JP)

In a future ambient information environment, the environment is expected to identify the situation from non-explicit human actions and give necessary information to eligible people. For this purpose, a multitude of sensors will be installed, and the environment is required to comprehensively evaluate the information obtained from these sensors and accurately identify the situation in real time. At the same time, various types of information presentation devices will also be installed. The environment must give appropriate people appropriate information by adequately combining these devices depending on the situation. 3D user interface is an important key technology to establish interfaces in this ambient information environment. However, establishing and maintaining such a system is not easy. It is expected to achieve major breakthroughs that are not possible by simply extending the currently available IT. Therefore, it is important to focus on biological natures that involve gigantic, complicated systems. 3D user interface based on new methodologies learned from biological systems is essential to achieve interfaces in neo-futuristic ambient information environments.

Ubiquitous Augmented Reality

Gudrun Klinker (TU München, DE)

Augmented Reality (AR) has recently emerged as a new three-dimensional user interface paradigm which allows users to access and visualize computer information embedded within their real environment. In real applications, it has become apparent, that AR cannot be seen as a stand-alone solution but rather has to be compared with and integrated into a large variety of user interface concepts that intelligently provide mobile users with ubiquitous access to information across a wide selection of devices - ranging from ambient and pervasive schemes over stationary displays to mobile information presentation schemes in head-mounted displays or on mobile screens (PDAs, mobile phones). Thus far, it is unclear how to present such information without overwhelming and confusing the users who - after all - still have to function safely within their real surroundings and typically have to focus on a real-life task rather than interacting with their computer.

In this talk, we present a number of technologies towards ubiquitous information presentation for mobile users that extend or complement Augmented Reality. We discuss, at the example of selected applications, trade-offs between them.

Forget about Acoustics!?

Torsten Kuhlen (RWTH Aachen, DE)

Although multimodality is a crucial feature in Virtual Reality, the acoustical component is often neglected. Additional auditory stimulation appears to significantly improve the sense of immersion into a virtual scene, however. In principle, the well-known binaural approach is capable of providing a high quality spatial sound rendering. However, it heavily relies on a perfect channel separation. At least for a moving listener, this separation is only achievable by headphones so far. While with head-mounted displays it might be quite acceptable to wear headphones, in CAVE-like environments loudspeakers are favored, if not a must. Therefore, we introduce a versatile and stable real-time binaural sound system based on (only four) loudspeakers with dynamic crosstalk cancellation, generating congruent visual and acoustical scenes even for a moving user. One of the major contributions of this comprehensive system is the realization as a software-only solution that makes it possible to use this technology on a standard PC basis.

Keywords: 3D audio, spatial acoustics, binaural synthesis, multimodal interaction

Joint work of: Kuhlen, Torsten; Assenmacher, Ingo; Lentz, Tobias

Semantic Reflection - design and development of intelligent interactive 3D graphics system

Marc Latoschik (Universität Bielefeld, DE)

The complexity of interactive 3D graphics systems continuously grows. Animated virtual worlds require several processes to generate a believable and consistent user impression. Advanced audio, physics, or AI-behaviors - to name a few - are nowadays omnipresent in research as well as in entertainment applications. This talk introduces a novel design and development paradigm for such interactive and complex systems. "Semantic Reflection" extends the well known reflection principle of current programming languages using an explicit semantic layer. It facilitates a uniform and integrative design of architectures, layouts, and interfaces even for complex systems. In addition, the paradigm provides an implicit AI representation useful - if not necessary - in areas like, e.g., multimodal interaction, physical simulation, or intelligent virtual agents.

Keywords: Intelligent Virtual Environments, AI & VR, Design paradigm

Endowed Virtual Objects: Hyper-Realistic Object Properties for Virtual Environments

Rob Lindeman (Worcester Polytechnic Institute, US)

Reality is a sensorially rich experience. However, the virtual environments we as researchers have been building for the past few decades are anything but rich. One goal of Virtual Environments (VEs) is to provide stimuli to the senses that allow the user to achieve willing suspension of disbelief that he is experiencing a virtual world. While it used to be that generating stimuli with high enough fidelity to fool the user was the main focus of our work, today we can produce visuals and sound that are (arguably) indistinguishable from reality. In addition, using motion-capture techniques and behavioral or physical simulation, the movement of characters and objects in our worlds also achieve a high degree of realism. The game industry has even made it so that we can do all of this at interactive frame rates using commodity hardware.

I believe the time has come to shift the focus of VE software design from a process-centric to an object-centric point of view. Several recent trends make this shift imperative in order for us to deliver attractive systems. The rise in popularity of massively-multiplayer online games has increased system complexity, and made robustness, verification, and testing a significant challenge. Second, the growing thirst for improved realism shows an increase in player sophistication, meaning that players' expectations about what constitutes a credible experience has risen. Finally, the proliferation of mobile devices means that users will begin to access online worlds using devices with very different processing capabilities and network bandwidths. Incremental improvements that follow the current

path of development will not be able to achieve success that satisfies the needs indicated by these trends.

In my proposed framework, the details of visual rendering, for example, are hidden below a layer of abstraction, allowing application designers to concentrate more on describing the objects and their interrelationships within an object repository. The abstraction layer would provide a standard interface for the low-level processing entities (i.e., the modality renderers) to access the user-specified properties to perform their well-defined tasks. This approach advocates having subsystems gather the object properties they require to do their work from a well-defined source (pull), rather than having the programmer pass them to the renderer (push). This is a subtle but important difference, as it promotes the definition of object properties (object-centric) over the processes themselves (process-centric).

This approach presents significant research challenges, include defining a complete, efficient, and extensible unified representation of object properties that is appropriate for every type of processing entity, providing high-level tools for non-technical people to create and manipulate objects in the repository, designing a low-level API for accessing and manipulating these properties, implementing specific instances of processing entities to test the design, providing efficient conversion of data from the unified format to modality-specific formats to maintain the required update rates, and implementing synchronization primitives between processing entities.

Keywords: Virtual reality, multi-modal, scalability, multiuser, objects

Virtual Human Systems for Interpersonal Interaction Education

Benjamin Lok (University of Florida, US)

In this talk, I will discuss the development of a virtual human (VH) system that provides opportunities for students to practice interpersonal scenarios. We focus on simulating patient-doctor experiences with highly interactive VH patients. This enables health professions students to interact with speech and gestures with life-sized VHs to practice and learn interpersonal communication skills. VH scenarios include a variety of patients (varied ethnicity, age, and gender) expressing conditions from abdominal pain to cranial nerve damage to breast mass screening. The VH system was developed jointly by a research group of medical faculty, educators, and computer scientists at the University of Florida, Medical College of Georgia, and Keele University, School of Pharmacy.

I will discuss our current work within the context of what we know about interactioning with virtual humans, and the impact of providing realistic human interactions, including using real tools, physiological measures, mannequin simulators, and virtual instructors. Also, this talk will cover the results of recent studies into racial/ethnicity biases, after-action reviews, communication skills,

validity, component evaluation, and high anxiety interactions (sexual history and abnormal findings).

Keywords: Virtual Humans

VR Tools for Disney Theme Park Design

Mark Mine (Walt Disney Imagineering, US)

In this talk I will describe some of the VR tools and techniques being used at Walt Disney Imagineering. I will give examples from recent work on the Finding Nemo Submarine Voyage at the Disneyland Resort. I will discuss some of the challenges of integrating virtual tools into a real world design and production pipeline.

Keywords: Virtual Reality, Architectural Walkthrough, Head-Mounted Displays

MPI Research and Avatars Walking in Virtual Reality

Betty Mohler (MPI für biologische Kybernetik - Tübingen, DE)

The Virtual Reality (VR) Research Group at the Max Planck Institute (MPI) for Biological Cybernetics investigates a number of topics that are necessary for the improvement and usefulness of virtual environments, such as biomechanical differences while walking in VR as compared to the real world, the need for self representation in VR, joint action in VR and a software library for VR (veLib). Scientists at MPI also use VR to investigate human perception, specfically space perception, self-motion perception and spatial cognition. This presentation will briefly cover the research projects of the VR Research Group at MPI for Biological Cybernetics and then in more detail discuss a new research program which improves the use of and investigates the impact of avatars and more natural interaction in virtual environments. More natural interaction in VR is increasingly practical as tracking technology improves and reduces in cost. Being able to naturally interact with other objects in the space and see one's self representation in the virtual space raises many qestions. Specifically, do head-mounted have a large enough field-of-view to allow a person to interact with near objects and see one's visual avatar while acting in the space? Does having a visual avatar influence one's actions in the virtual space? Finally, how does seeing one's self-representation impact one's experience in VR? These questions have already started to be addressed at the MPI with the use of a real-time fully-articulated avatar.

Keywords: Avatars, perception, self-motion

Scalable simulation and visualization - Challenges in and solutions for massively parallel computing and networked virtual reality applications

Stephan Olbrich (Universität Düsseldorf, DE)

Visual data analysis of results of computational fluid dynamics is challenging, especially in the context of peta-scale high-performance computing where parallel scalability has to be increased significantly, and explorative virtual reality application scenarios have to be supported in a networked, balanced process chain. The results of a simulation cannot be stored and interactively post-processed in a conventional way, since data volume and data flow requirements cannot be handled in massively parallel computing scenarios where 10^10 grid points and 10^4 time steps produce up to 1 PetaByte of raw data for one simulation run. We present solutions for highly scalable data extraction and visualization, which are implemented as part of our DSVR - distributed simulation and virtual reality - framework. Unsteady scalar or vector data fields on high-resolution 3D grids have to be processed. Since the numerical simulation on parallel computers typically provides partitioned data fields on separate compute nodes, we also focus on parallelization and speed-up analysis.

Isosurfaces are useful for visualization of scalar data on a 3D grid. We have developed a scalable isosurface extraction algorithm for the purpose of volume visualization. It combines the marching-cubes algorithm with configurable, vertex-cluster-based polygon simplification. In this case, the data extracts are polygonal 3D scenes. Data extraction and reduction is tightly coupled to the simulation and parallelized - based on domain decomposition and MPI programming - to support multi-core and cluster based high-performance computers.

Particle tracing or path lines are techniques for visualization of unsteady flows. They are usually combined with interactive or topology-oriented, property-controlled seeding strategies. To avoid time-consuming recalculations, especially in the context of large scale, massively parallel numerical simulations of unsteady flows, we generate traces at generalized seeding patterns. The resulting traced particles' or path lines' geometry 3D scene data is attributed by separately given or derived property data at the respective position.

Integrated into a networked processing chain and incorporating a streaming server, optional interactively parameterized on-the-fly post-filtering and 3D presentation is realized on the basis of a multiplexed 3D geometry and property data stream. As result, explorative, real-time and presentation scenarios are supported in a virtual reality environment, providing play-out of smooth 3D animations at specified frame rates, which can be navigated interactively.

Second Skin: Wearable fabric for Bio-I/O platform

Ramesh Raskar (MIT - Cambridge, US)

How can we sense and actuate densely at every point on a human body? Taking the mantra of Henry Fuchs of 'every milimeter at every milisecond' for projected illumination into the Motion Tracking world, I propose 'Second Skin' a wearable fabric for bio/io feedback.

For a progress towards Second Skin, we last year built a motion capture solution using multi-LED projectors as base station and photosensing tags as markers. It works at 500 Hz with Id for each Marker, Captures in Natural Environment (using visually imperceptible tags and works in ambient lighting). It supports Unlimited Number of Tags so that one can build a Light sensitive fabric for dense sampling. In addition it is Non-imaging, allowing complete privacy. Finally, by avoiding high speed cameras, we can build the complete system (Base station and tags) for only a few 10's $.

If we can do full body scan of actions, there will be a range of applications in elderly care, patients monitoring, athletes improvements and performance capture. We can detect all range of motions including breathing, small twists, multiple segments or people.

Keywords: Motion Capture, Vibro-tactile, RFIG, Biological I/O

Full Paper:
 http://raskar.info

See also: Associate Professor, MIT Media Lab

VR for engineering design & engineering design of VR systems

Simon Richir (ENSAM Presence & Innovation Laboratory - Laval, FR)

I would like to discuss around three themes, mainly focused on engineering design and user centred approach. We focus on the area of applied research and industry transfer.

1/ Methodology to design professional VR systems Video games industry, as cinema industry before, developed its own methods to create videogames or movies. Then appear specific jobs linked to that processes (e.g. game designer). VR industry (it was born?) has not yet developed clear methodology for the engineering design of professional VR systems. We propose a user centred methodology, the I2I method (Immersion & Interaction for Innovation).

2/ Living Lab approach VR systems should be designed using an anthropocentric (human centred) approach. How the new European organisations called "Living Labs" could use VR to develop their activities? We plan to start a Living Lab experiment in Laval Virtual pole.

3/ VR for engineering design & collaborative work within SMEs The engineering design of industrial products benefit from the use of VR technologies.

Automotive & aeronautical industries use VR everyday. But what to do if you are a SME? (Small or Medium Enterprise) We started developing a collaborative VR system for some SMEs working on kids products design.

Keywords: VR, engineering design, SMEs, collaborative work, innovation process, Living Lab

VR3L Virtual Reality Living Lab of Laval

Simon Richir (ENSAM Presence & Innovation Laboratory - Laval, FR)

VR3L Virtual Reality Living Lab of Laval

Laval Virtual VR Pole What is a Living Lab ? VR3L concept P&i team projects

Keywords: Virtual Reality Living Lab

Motion Capture and Animation of Man-Machine Interaction.

Bodo Rosenhahn (MPI für Informatik - Saarbrücken, DE)

The presentation deals with modeling, markerless tracking and animation of constricted kinematic chains, athletes interacting with sports gear or people interacting with the environment.

In contrast to classical markerless tracking, the modeling of external constraints during motion capture allows to reduce the search space to a desired manifold which again helps to avoid local minima and resolve ambiguities during tracking. The improved tracking results are also reflected in more realistic animations. Experimental results on several scenarios show the general applicability of our approach.

The presentation summarizes three recent works published at RobVis 2008, CVPR 2008 and DAGM 2008.

Recent R&D of haptic systems - SPIDAR -

Makoto Sato (Tokyo Inst. of Technology, JP)

In this talk, recent research and develoment of haptic systems using SPIDAR, string-based force display will be introduced. Future directions of R&D of SPIDAR systems will be also discussed.

Keywords: Force display, SPIDAR, haptic, virtual reality

Augmented Reality 2.0.

Dieter Schmalstieg (TU Graz, AT)

The idea of using Augmented Reality (AR) to present geo-referenced information on a global scale has been around for a number of years, but no break through in acceptance of AR has happened. The authors speculates that finally the necessary enabling technologies to deploy AR on a massive scale are in place: Camera cell phones provide an inexpensive, versatile platform for AR application, while the social networking technology of Web 2.0 provides a large-scale infrastructure and also a societal awareness for collaborative producing, organizing and consuming online content, specifically geo-referenced content. The talk will present existing results for phone-based AR and describe how Web technology can be used to build Augmented Reality 2.0.

Global Illumination and Presence in Virtual Reality

Mel Slater (TU of Catalonia - Barcelona, ES)

Greater realism in all senses (with the two meanings of that word) might be thought to be the key to achieving virtual environments in which people respond realistically. I will discuss two experiments in which we examined the impact on people's responses of various types of illumination realism (simple, ray tracing and global). The results suggest that while illumination realism may be useful (certainly so in some applications) what may be more useful is correlation between participant body actions and observable reactions in the virtual world.

Keywords: Virtual reality, global illumination, presence

Telecollabration across display types

Anthony Steed (University College London, GB)

Telecollaboration remains an important motivating application for virtual environments systems. With quite simple immersive system, we can already observe remote participants undertaking quite complex spatial tasks sucessfully.

In this talk, we discuss some recent work on tele-collaboration using eye-gaze tracking. The addition of eye-gaze clearly supports some object-focussed tasks, but it also contains subtle social cues. This has led to our changing how we approach the evaluation of our collaborative systems. I will also discuss some of the associated technical challenges.

I will end by discussing some challenges for collaboration between different classes of AR, MR and VR systems.

Next Generation 3D Interaction Techniques

Wolfgang Stuerzlinger (York University - Toronto, CA)

We present a set of guidelines for 3D positioning techniques. These guidelines are intended for developers of object interaction schemes in 3D games, modeling packages, computer aided design systems, and virtual environments. The guidelines promote intuitive object movement techniques in these types of environments.

Ambient Information Society and VR/MR

Haruo Takemura (Osaka University, JP)

The one step beyond ubiquitous computing society is supposed to be an ambient information society, where multiple sensors located in real environment senses various information. The talk will relate possible VR/MR applications in such an information society, where location based interaction using VR/MR technology can be used to facilitate user interaction in the environment.

Dynamically configurable system design is required to effectively run applications in such frame work.

This presentation can be 10-15 min length to keep more time for discussion.

Keywords: Ambient Information Society, Ambient user interface

Tracking of human body motions using very few inertial sensors

Andreas Weber (Universität Bonn, DE)

Tracking of the user's movements is important for VR systems.

It is desirable that the tracking can be done with as little effort for the user as possible. In this work-in-progress talk we show that trackings of human whole body motions are possibly in several cases by a surprisingly small number of inertial sensors, if semantic pre-classifications of the motions are available, and motion data bases can be used to synthesize missing degrees of freedom.

For locomotions even two sensors attached to one hand and one foot already give good results, and for several other motions 4 inertial sensors attached to the feet and hands are sufficient.

Keywords: Tracking, motion capture, sparse marker techniques

Technologies for Telepresence Over Time, Space, and Imagination

Greg Welch (University of North Carolina- Chapel Hill, US)

In this brief talk I will share a little about some VR-related work I have been doing over the years, along with some new desires and rough ideas I have, all characterized as technologies for telepresence over time, space, and imagination.

Keywords: Telepresence cameras projectors virtual augmented reality

Recent work and thoughts: Redirected walking, walking-in-place, and using logs of behaviors

Mary Whitton (University of North Carolina- Chapel Hill, US)

Interfaces allowing you to move around "on foot" in virtual scenes are problematic: really walking is limited by the effective area of the head-tracker, and it is difficult to make a walking-in-place interface accommodate movement in any direction, fine user control of speed,and fine position adjustments (without forward motion). We have ongoing work on improving and eliminating limitations to Razzaque's Redirected Walking technique and ongoing work developing more usable walking-in-place interfaces. I'll report recent developments in each of these areas.

Evaluating locomotion interfaces led us to begin using logs of user behaviors (head position data) as a metric for comparison of locomotion interfaces. The analysis shows how poorly synthetic locomotion algorithms approximate really walking. This work led us to look at logs of game play to understand what they could help us understand. I'll show some results, describe the current roadblocks, and share a vision of what such logs might enable.

Technologies for Making the Hand Usable as an Interaction Device in VR

Gabriel Zachmann (TU Clausthal, DE)

The hand is our most versatile and most frequently used "interaction device" with the real world.

However, in virtual environments, the virtual hand is one of the most rarely used interaction metaphors. In this talk I will highlight some of the ongoing research we have been doing in the past few years to achieve the goal of making the virtual hand as versatile as the real hand.

In particular, I will talk about collision detection, hand tracking, and natural manipulation.

Smooth motion and crosstalk reduction: how to evaluate the user experience ?

Robert van Liere (CWI - Amsterdam, NL)

In this talk, I will ask the question of how to evaluate the experience of percieving smooth motion and cross talk reduction of large dynamic scenes. During the past few year we have developed algorithms for smooth motion of (large) dynamic scenes and cross talk reduction on CRT displays. The user response extremely positive. However, although we have evaluated many aspects of cross talk reduction, we still believe that we have not found a way to evalute the user experience, and quantify what makes smooth motion and cross talk reduction so attractive.

Keywords: Smooth motion, cross talk reduction, evaluation