Course Notes
Introduction to Virtual Reality

SIGGRAPH 96

Organizers:
Anselmo Lastra
Henry Fuchs
University of North Carolina, Chapel Hill

Lecturers:
Pat Gelband, Sense8
Stephen Ghee, Division, Ltd.
Randy Pausch, University of Virginia
Hans Weber, University of North Carolina

Abstract
This course provides an introduction to virtual reality using immersive displays. It covers system requirements, hardware, design of applications, and the implementation of virtual worlds. The emphasis of the course is on the practical issues that must be addressed to begin working in virtual environments.

Introduction to Virtual Reality
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Schedule

Virtual Reality: Past, Present, and Future *Henry Fuchs*	30 minutes
Technology for Virtual Reality *Anselmo Lastra*	1 hour 15 minutes
Break	
Interaction in a Virtual Environment *Hans Weber*	1 hour 15 minutes
Lunch	
Alice: A Rapid Prototyping System for Virtual Reality *Randy Pausch*	1 hour
Programming Virtual Worlds *Steven Ghee*	1 hour
Break	
Technology for Virtual Reality and Real-Time 3D Content Development *Pat Gelband*	1 hour

Course Description

Anselmo Lastra

For years there has been a great deal of interest in the field of virtual reality. However, initially there was not much user-level activity in the field, mostly because it was very hard for people to experiment with VR. The expense and the difficulty of setting up a system kept all but a hardy and persistent few from setting up laboratories. Within the last few years, however, a variety of hardware and software have become available. These new products enable interested parties with moderate budgets to set up VR systems for use in areas such as visualization, and human-computer interaction. This course is intended to get those people started working with virtual worlds.

The morning begins with an overview of a typical VR system, followed by a description of the basic hardware components and how to choose them. This section is important because selecting hardware for VR systems is not straightforward. The course notes will show in detail what hardware is available, but the class time will mostly be spent on describing what the important hardware specifications mean.

The second half of the morning is devoted to the design of virtual worlds. Using applications as case studies, we will illustrate modes of interaction in the virtual environment. The intent is to show the students what sorts of things are possible, and to guide them in solving their application problems using virtual worlds techniques. This section of the course will be illustrated with video tape of a variety of applications for modeling and visualization (architectural, medical, scientific) from the University of North Carolina.

The afternoon session shows the students how to implement their virtual worlds using three very interesting development systems. Rather than survey the field of VR software, we decided to describe and contrast three systems, two of which are the leading commercial development systems, while the third is freely available. The intent is to provide enough information for the students to get started, but not bias their choice of software unduly.

The first system, Alice, is an interpreted, object-oriented rapid-prototyping environment. A goal for Alice is to allow programmers to build virtual worlds based on a 10 page, two-hour long tutorial. The second system, dVS, is a platform-independent software environment for the development of virtual reality applications, based on a distributed, multi-server architecture. dVS supports multiple-host and multiple-user virtual environments. Higher level functions are provided in the form of an object-based toolkit called VCTools. The final section of the course will cover the process of developing a virtual environment and review the key design issues that have to be tackled in such a development. WorldToolKit will be used to interactively construct such a world and to demonstrate the key concepts. WorldToolKit is a cross-platform 3D simulation development tool used for constructing virtual environments.

Speaker Biographies

Henry Fuchs

Henry Fuchs has been involved in three-dimensional biomedical imaging and graphics since 1969 and in work related to head-mounted displays since 1970. He has become increasingly involved in the intervening years in the field of virtual reality in medicine through his work on the Medical Imaging Program Project and his research in head-mounted displays. Prof. Fuchs is one of the inventors of the Pixel-Planes high-performance graphics engine, currently the world's fastest graphics computer, and is a principal investigator for the work on its successor, PixelFlow. He has over eighty publications resulting from his research in computer graphics, particularly interactive, three-dimensional computer graphics. He is Federico Gil Professor of Computer Science and Adjunct Professor of Radiation Oncology at the University of North Carolina at Chapel Hill. He received a Ph.D. in Computer Science from the University of Utah in 1975. He received the 1992 Computer Graphics Achievement Award from ACM/SIGGRAPH and the 1992 National Computer Graphics Association Academic Award. He has been a member of the National Research Council Computer Science and Telecommunications Board since 1993. He is on the editorial board of the newly formed IEEE journal, Transactions on Visualization and Computer Graphics, and the Virtual Reality Society Journal He was an associate editor of ACM Transactions on Graphics (1983-1988) and the guest editor of its first issue (Jan 1982). He was the technical program chair for ACM Siggraph'81 Conference, chairman of the 1985 Chapel Hill Conference on Advanced Research in VLSI, chairman of the 1986 Chapel Hill Workshop on Interactive 3D Graphics, co-director of the NATO Advanced Research Workshop on 3D Imaging in Medicine (1990), and co-chair of the National Science Foundation Workshop on Research Directions in Virtual Environments (1992). He has served on industrial advisory boards for many years, including most recently the Fraunhofer Computer Graphics Research Group, the U.S. branch of the Fraunhofer Institute, based in Germany, perhaps the world's largest computer graphics research institution.

Pat Gelband

Pat Gelband founded Sense8 Corporation in 1989, where she has been involved in all aspects of product development. Before that she was on Autodesk's cyberspace research team. She has a Ph.D. in theoretical physics from Stanford.

Steven Ghee

Steve Ghee, BSc (1st class honours) in MicroElectronics and Microprocessor Applications from the University of Newcastle Upon Tyne. One of the founders of Division, Steve now holds the post of Director of Engineering. Steve (alone!) wrote the original dVS system, and is now tasked with defining new features in all Division's VR products (both hardware and software).

Anselmo Lastra

Anselmo Lastra is a Research Assistant Professor of Computer Science at the University of North Carolina at Chapel Hill. He serves as the software manager for the Pixel-Planes/PixelFlow research team. The research group is currently working on PixelFlow, a scalable graphics computer expected to perform more than an order of magnitude faster than their previous machine, Pixel-Planes 5. Dr. Lastra received Ph. D. and M.S. degrees in Computer Science from Duke University and a B.S.E.E. from the Georgia Institute of Technology. Prior to coming to North Carolina, he was a project manager at Coulter Electronics, leading the development of medical instrumentation, and was a consultant at AT & T Bell Laboratories.

Randy Pausch

Randy Pausch is an Associate Professor of Computer Science at the University of Virginia. He received a B.S. in Computer Science from Brown University in 1982 and a Ph.D. in Computer Science from Carnegie Mellon in 1988. He is a National Science Foundation Presidential Young Investigator and a Lilly Foundation Teaching Fellow. His primary interests are human-computer interaction and undergraduate education. In 1995, he spent a sabbatical with the Walt Disney Imagineering Virtual Reality Studio.

Hans Weber

Hans Weber is a doctoral candidate at the University of North Carolina at Chapel Hill and is currently working on his thesis, "Wayfinding in Virtual Environment Systems for Architectural Visualization and Navigation Training". He received an A.B. degree in Computer Science from Harvard University in 1991 and has been working on the Architectural Walkthrough Project at UNC since that time. His interests include virtual environments systems, human-computer interaction, and global illumination algorithms.