In the Proceedings of VRAIS ‘95.

VRAIS Panel on Networked Virtual Environments

Michael J. Zyda, Panel Chair
Computer Science Department
Naval Postgraduate School
Monterey, California 93943-5118 USA
+1-408-656-2305
zyda@trouble.cs.nps.navy.mil

ABSTRACT

This panel examines the current and future issues regarding the development of networked virtual environments and teleoperation systems.

KEYWORDS: Virtual Reality, Distributed Interactive Simulation, Distributed Interactive Entertainment, Large-scale Virtual Environments.

INTRODUCTION

The development of multi-user networked virtual worlds has become a major area of interest to the virtual reality community. The realization of high bandwidth wide area communications, the success of World Wide Web applications such as the National Center for Supercomputing Application’s Mosaic browser, and government funding of Distributed Interactive Simulation (DIS) has fueled the desire to expand networked virtual worlds beyond local area networks. However, the Internet has proved a challenging environment for real-time applications such as interactive virtual worlds and multimedia. The panel looks at what research groups are doing to meet the challenge and examine the state-of -the-art in networked virtual environment and teleoperation systems.

MICHAEL ZYDA, SENIOR EDITOR FOR VIRTUAL ENVIRONMENTS FOR PRESENCE

Panel Chair

Michael Zyda is a Professor in the Department of Computer Science at the Naval Postgraduate School, Monterey, California. Professor Zyda is also the Academic Associate and Associate Chair for Academic Affairs in that department. He has been at NPS since February of 1984. Professor Zyda’s main focus in research is in the area of computer graphics, specifically the development of large-scale, networked 3D virtual environments and visual simulation systems. Professor Zyda is a member of the National Academy of Sciences’ Committee on Virtual Reality Research and Development. Professor Zyda is also the Senior Editor for Virtual Environments for the MIT Press quarterly PRESENCE, the journal of teleoperation and virtual environments. For that journal, Professor Zyda has co-edited special issues on “Pacific Rim Virtual Reality and Telepresence”, on “The Application of Virtual Environments to Architecture, Building and Large Structure Design”, and on “Networked Virtual Environments and Teleoperation”. Professor Zyda has been active with the Symposium on Interactive 3D Graphics and was the chair of the 1990 conference, held at Snowbird, Utah and is the chair of the 1995 Symposium, to be held in Monterey, California.

The networking of virtual environments is how we go from one player on a workstation to many cooperating, interactive players at both local and distant sites. Current technology limits us to systems with approximately 300 players using Ethernet and T1 links. We present what is possible today with such technology, what we will be able to achieve near-term and what we need to work on to get us to the large-scale, networked virtual environment of thousands of players. There are hard problems involved in networking virtual environment systems. The key message perhaps is that such design is not done“last” but rather integrated into the software from the start. Another key point is that network protocols for virtual environments must be rapidly reconfigurable while the VE is running.

RICH GOSSWEILER, UNIVERSITY OF VIRGINIA

Fundamentals in Developing Distributed Multi-User Virtual Environments

Rich Gossweiler is the senior Ph.D. student in the User Interface Group at the University of Virginia. He played a major role in designing and developing the underlying distributed virtual environment platform currently employed by the Alice graphics system. For his Ph.D., he is researching application-independent time-critical rendering techniques. Recent work includes an introductory-level tutorial describing how to implement a distributed multi-

participant virtual environment.

Having observed that it is difficult to begin to explore networked virtual environments, this tutorial is intended for undergraduate students who are competent programmers and who now wish to implement a distributed, multi-participant application. It describes the fundamental concepts of distributed computing for multi-player simulations and includes a C source code template available via the Internet. The template was designed so that students can quickly create their own distributed applications. The template source code uses broadcast communication and a technique called dead-reckoning to improve performance.

JOHN MORRISON, MAK TECHNOLOGIES

Experiences with DIS-based Virtual Environments

MaK was founded in October 1990 by John Morrison and Warren Katz, two well-known developers of the SIMNET system. MaK has one of the highest concentrations of experienced SIMNET and DIS developers in the industry, measured against companies of any size. MaK personnel have participated in every large DIS simulation contract since the invention of the technology, including SIMNET, Advanced Distributed Simulations Testbed, War Breaker, and the emerging Synthetic Theater of War (STOW).

Three challenges to building large Networked Virtual Environments are ever-increasing complexity, scalability, and portability. We require a software infrastructure to overcome these challenges. We examine one such example software infrastructure which is currently the basis of dozens of virtual environment efforts. Its use of object-oriented inheritance and its use of an interpreted configuration programming language meets these requirements while achieving the efficiency to support large numbers of entities on current-generation hardware.

SANDEEP SINGHAL, DISTRIBUTED SYSTEMS GROUP, STANFORD

Strategies for Minimizing Network Traffic for Large-scale Virtual Environments

Sandeep K. Singhal's research is in communication protocols and algorithms for dead reckoning -- the problem of accurately displaying the real-time position, orientation, and structure of objects actually being modeled on remote machines. He is also researching how to enable dynamic multicast channel aggregation by applications. The PARADISE Project at Stanford is a testbed for his work.

Distributed virtual reality systems require accurate, efficient remote rendering of animated entities in the virtual environment. Position, velocity, and acceleration information about each player is maintained at the player's local machine, but remote hosts must display this information in real-time to support interaction between users across the network. Prior applications have transmitted position information at the local frame rate, or they have relied on dead reckoning protocols using higher derivative information to extrapolate entity position between less frequent updates. These approaches require considerable network bandwidth and at times exhibit poor behavior. We describe a position history-based protocol whose update packets contain only position information. Our evaluation suggests that the position history-based protocol provides a network-scalable solution for generating smooth, accurate rendering of remote entities.

MICHAEL MACEDONIA, NAVAL POSTGRADUATE SCHOOL

Mega-Scale Virtual Environments

Michael R. Macedonia is a US Army major and a Ph.D. student in computer science at the Naval Postgraduate School. His research is directed toward the development of software architectures supporting large-scale distributed virtual environments.

We present our ideas in the context of NPSNET-IV, the first 3D virtual environment that incorporates both the DIS application protocol and the IP Multicast network protocol for multi-player simulation over the Internet. The fundamental idea behind the NPSNET approach is to logically partition virtual environments by associating spatial, temporal, and functionally related entity classes with network multicast groups. This is accomplished by exploiting the actual characteristics of the real-world large scale environments that are simulated, and by focusing or restricting an entity's processing and network resources to its area of interest via a local Area of Interest Manager (AOIM).

RESOURCES

The special double issue of the journal PRESENCE on Networked Virtual Environments includes articles from all the members of the panel. See *ftp://taurus.cs.nps.navy.mil/pub/PRESENCE_MOSAIC/presence_mosaic.html* for more details. Additional information from each of the members of the panel is available via WWW or email:

John Morrison, jm@mak.com.

Rich Gossweiler, ftp://uvacs.cs.virginia.edu/pub/distgame.

Sandeep Singhal, http://www-dsg.stanford.edu/SandeepSinghal.html.

Mike Zyda, Mike Macedonia, ftp://taurus.cs.nps.navy.mil/pub/NPSNET_MOSAIC/npsnet_mosaic.html.