Discovery and Analysis of Communication Patterns in Complex Network-based Systems using Virtual Environments

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Motivation

In general, investigating and understanding the content of large-scale multidimensional information is a major impediment in the application of basic scientific research. Scientists remain separated from their data, with the computer acting as a recalcitrant intermediary.
Homunculus Project

Hypothesis: The development and use of immersive virtual reality interfaces to complex high performance computer simulations and systems will greatly enhance scientific discovery.
**Goals of Homunculus Project**

- Improved human comprehension of large-scale complex simulations and data
- Creation of virtual laboratories, tools, and methods for scientists
- Continuous testing and quantitative evaluation
Tool Development

- Flatland - VE development tool
- eLoom - Network specification language and simulation engine
- AI - Realtime rulebased controller
Tool: Flatland

- Developed at HPCERC, UNM
- Object oriented
- OpenGL/GLUT/SDL based
- IRIX/Linux/Unix/OSX(?)
- Open source

www.hpcerc.unm.edu/homunculus/
Flatland....
Flatland Features

- Modular, Dynamic, Configurable
- Collaboration
- Internet Integration
- Interaction metaphors
- HPC interfaces
- 3D sound localization
- Haptics
- 3D data representation
- Parallel & Distributed
- Multiple display formats
Displays...
Third Person Collaboration

Access Grid Interfaces
First Person Collaboration

Average Throughput vs. Number of users

Throughput curve and linear curve ($y = x$)
Tool: eLoom

- Network & Simulation Specification
- Hierarchical and modular
- Multi-timescale simulation
- Interfaces to visualization system
- Parallel and Serial execution
Research Projects

- Neural System Modeling (Boeing)
- TOUCH Project (HHS)
- Scientific Vis (LANL)
- Program Vis and Comprehension (KRL)
- Transactional Graph Vis (SNL)
- Parallel Computer Vis (LANL)
- Network Intrusion Vis (LANL)
- Nondestructive Chip Vis (SNL)
- Art & Science (UNM ATC & Rockefeller)
Immersive tools
Sponsored by Los Alamos National Laboratories
Avatars & Human Simulations

Sponsored by HHS
Integrated Circuits

Sponsored by Sandia National Laboratories
Transactional Graphs
Program Vis.

Sponsored by Khoral Research Inc.
Autonomous Systems, Neural Networks
Neural Networks
Other examples

Self-organizing Feature Map

Hopfield

Multi-layer Perceptron

Sponsored by Dept. of ECE, UNM
Parallel Computer

Sponsored by Los Alamos National Laboratories
Switch Connections

Quaternary Fat Tree

Adjacency Matrix
Fat H-Tree Structure

H-Tree

Fat H-Tree
Fat H-Trees
Parallel Computers
Network Intrusion

Sponsored by Los Alamos National Laboratories
Network Layout

Sponsored by Los Alamos National Laboratories
Future work

- Human subjects testing of interfaces, representations, collaboration, and knowledge acquisition,
- Enhanced integration with high performance computing systems,
- Expansion of sound and haptics modalities,
- Continued application development to drive feature enhancement.
Collaborators ...

- Karen Haines
- Jim Ahrens
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- Steve Smith
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- David Modl

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- Stan Saiki
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The team...

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