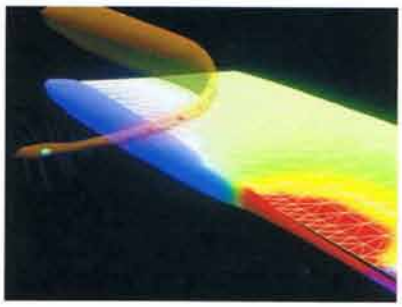
ELECTRONIC THEATER

ART AND DESIGN SHOW

SIGKIDS

THE EDGE

VROOM



VISUAL PROCEEDING

The Art and Interdisciplinary Programs of SIGGRAPH 94

COMPUTER GRAPHICS
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INTRODUCTION

Attendees experience the actual use and future direction of scientific visualization in computational science and engineering, with emphasis on interactive and collaborative problem solving, in VROOM, the Virtual Reality Room. Virtual environments not only enable scientists to view massive datasets, they also enable them to enter into and interact with the data. Scientists can become smaller than an atom or larger than the universe. They can stand in the middle of a thunderstorm or travel through the human bloodstream. At SIGGRAPH 94, attendees share this full-data immersion experience with the actual scientists, as the scientists conduct a guided tour and explain which areas are of interest to the high-performance computing and communications (HPCC) community.

Over 40 projects involving over 200 researchers and programmers are demonstrated for four days at SIGGRAPH 94. Using CAVE and BOOM virtual reality technologies, researchers show immersive visualizations of their work and demonstrate interactive steering of their program codes using local high-speed networking, massive datastores, superworkstations, supercomputers, and scientific instrumentation. VROOM highlights computational science and engineering applications and computer graphics research. It also has a kid-centered application component called CitySpace.

VROOM's primary goal is to encourage the development of teams, tools, hardware, system software, and human interface models on an accelerated schedule. New interaction paradigms for virtual environments tuned to science and engineering will emerge, which will be the basis for future intelligent user interfaces for the emerging national information infrastructure.

Attendees gain a vision of the 1990's scientific "cyberworkspace." Virtual reality experiences enable researchers to interactively explore their scientific domains, play "what-if" games by modifying their codes, and view the resulting visualizations in close-to-real time. Virtual reality is recognized as an "intelligent user interface" to the emerging national information infrastructure. It will allow computational scientists and engineers access to HPCC-enabling technologies, and it will put the "human in the loop" for timely data analysis and understanding.

Three CAVEs

VROOM features three CAVEs in one place! A CAVE is a multi-person, room-sized, high-resolution, 3D video and audio environment. At SIGGRAPH 94, it is a theater 10 feet by 10 feet by 9 feet with three rear-projection screens for walls and a down-projection screen for the floor. Electrohome Marquis 8000 projectors throw full-color workstation fields (1280x512 stereo) onto the screens at 120 Hz, generating a surrounding composite image of 2,000-4,000 linear pixel resolution. Computer-controlled audio provides sampled sound and sonification capabilities through multiple speakers.

A user's head and hand are tracked with Polhemus or Ascension tethered electromagnetic sensors. Stereographics' LCD stereo shutter glasses are used to separate the alternate fields going to the eyes. A Silicon Graphics Onyx with three Reality Engines is used to create the imagery projected onto three of the four walls. The CAVE's theater area sits in a light-tight room (minimally 30x20x13 feet), and the projectors' optics are folded by mirrors.

As the viewer wearing the location sensor moves within the CAVE's display boundaries, correct perspective and stereo projections of the environment are updated, and the image moves with and surrounds the viewer. Other viewers in the CAVE are like passengers in a bus, along for the ride!

"CAVE," the name selected for this virtual reality theater, is both a recursive acronym (Cave Automatic Virtual Environment) and a reference to "The Simile of the Cave" found in Plato's "Republic," in which the philosopher explored the ideas of perception, reality, and illusion. Plato used the analogy of a person facing the back of a cave filled with shadows, where the shadows are the only basis for understanding what real objects are.

The CAVE, developed by the Electronic Visualization Laboratory at the University of Illinois at Chicago, premiered at SIGGRAPH 92. It is achieving national recognition as an excellent virtual reality prototype and a compelling display environment for computational science and engineering data.

CAVE Interactive Steering of Computer Simulations

Applications can run in one or two modes: locally on the Onyx/CAVE and/or distributed between a backend computer and the Onyx/CAVE. In local mode, CAVE participants explore precomputed datasets. In distributed computing mode, CAVE participants may "interactively steer" their simulation codes running on an onsite IBM SP or on SGI Challenge multi-processor computers.

This ability enables CAVE users to experience and explore visualizations of precomputed datasets, identify an area they want to enhance, and then invoke simulation codes on the networked computer to compute new datasets. The Challenge or SP generates new data, which is then transferred to the Onyx for rendering and display in the CAVE.

Scientific simulation codes are typically large and complex. They require HPCC resources – massively parallel processors, vector processors, massive datastores, large memories, or high-speed networks – to run efficiently. Depending on the dataset and type of analysis scientists select, they set up their simulation codes to calculate greater detail, a different time step, or a different state defined by new parameters. In some instances, codes can be executed locally but take longer to run, so the Challenge and SP are used to provide faster simulation.

BOOM ROOM

The VROOM BOOM ROOM contains a collection of BOOM (Binocular Omni-Oriented Monitors) virtual reality technologies. The BOOM uses small TV screens and wide-field optics suspended by a counterbalanced mechanical arm in front of a viewer's eyes. Fakespace, Inc. developed these light-weight BOOMs to provide accurate lag-free tracking. They are driven by Silicon Graphics workstations to create virtual scenes in real time.

NCSA Mosaic

Hypermedia is an excellent mechanism for the dissemination of visualization-based discovery. Workstations displaying NCSA Mosaic-based documentation of virtual reality visualizations taking place in the CAVEs and BOOMs are located in open areas of VROOM so attendees can learn more about the science and engineering applications on display. After the conference, these documents, complete with text, images, sounds, and animations, are available over the Internet, under the Electronic Visualization Laboratory home page.

NCSA Mosaic is a hypermedia-based system for discovering and retrieving information over the network. It uses existing Internet protocols and formats to tie into as broad a range of information as possible. It also provides capabilities for asynchronous collaboration based on this distributed model of information access and control, including support for document construction, modification, and annotation.

VROOM Applications

VROOM projects represent a variety of computational science and engineering applications:

Algorithms
Artificial life
Astrophysics
Atmospheric science
Biochemistry
Biomedicine
Collaborative networked visualization
Earth science
Engineering
Fluid mechanics
Fusion physics/energy research
Geometric modeling
Mathematics
Medical imaging
Molecular biology
Neuroscience
Oceanography
Performance analysis
Situational training

The Virtual Windtunnel

The Virtual Windtunnel is an application of virtual reality to the visualization of pre-computed simulations of air flow around aircraft. Through a natural 3D display and control interface, the Virtual Windtunnel provides a platform for intuitive and rapid investigation of complex airflows.

CATEGORY
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RealEyes: A System for Visualizing Very Large Physical Structures

Both airplanes and space stations are extraordinarily complex systems. They each contain millions of parts. Determining how well large assemblies of parts will fit together (or how they won't) while they are still at the design stage is a very important task, because fixing these sorts of design problems after the parts are manufactured is far more difficult and expensive than fixing the problems at the design stage.

Boeing demonstrates some very large, complex CAD models of a Boeing 747 interior and Space Station Freedom. These models are taken directly from the design engineers, and each contains several million polygons (several orders of magnitude more than models displayed in other systems). They are quite detailed, right down to the airflow controls above each seat and the hot/cold labels on the water faucets.

This virtual reality system allows engineers to discover and analyze problems using much larger collections of CAD models than ever before. The navigation interface is easily learned by novices, and it is much more powerful in the hands of expert users than any screen-based interface known to the Boeing engineers who designed it.

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EQUIPMENT
BOOM

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