The *OptIPuter*: a new approach to volume visualization of large seismic datasets

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Description of the Proposal Paper

Scientists at Scripps Institution of Oceanography, in collaboration with researchers at UCSD, the Electronic Visualization Laboratory [EVL] at the University of Illinois at Chicago [UIC], and the San Diego Supercomputer Center [SDSC] have embarked on a project to redefine how visualization is optimized at the hardware, software, and networking layers. We anticipate this will dramatically improve rendering performance, while significantly reducing cost. The premise behind this new approach to visualization computing is the *hollowing-out* of the computer. In this innovative approach, individual parts of a computer, such as CPUs, memory, graphic-boards, disk drives, are interconnected via the network rather than backplanes or busses. This is now possible because of the on-going development of fast networks and switches that enable 10 Gigabit (OC-192) speeds or greater. As network speeds increase, less importance is placed on the location of the individual parts of a computer, but on the network layer that connects all the various pieces, and the software that is optimized to run in this environment. Our collaborative group from UCSD and UIC, under the leadership of Dr. Larry Smarr, has recently been awarded a large, 5 year NSF Information Technology Research (ITR) grant to build the first optical-networked computer or *OptIPuter*. The *level-0 OpIPuter* is an *IA-32* cluster computer, with 10 dual-CPU *Pentium 4* 1-U blades, with *nVidia* Qudro-FX graphics cards. Each blade will be responsible for one-eight of the viewing screen (a dual-head IBM Big Bertha T221 Display, 7680 by 2400 pixels); the initial *hollowing-out* will involve interconnecting the individual blades with multi-lamda (λ) fiber, and then connecting two identical systems between Illinois and California to demonstrate how cluster computing and visualization can be distributed across two-thirds of United States. Over the next 4 years, more individual computer parts will be *hollowed-out* to rigorously test the notion of an *OptIPuter*.

Application

Two disciplines will drive both visualization and computing in this project: Earth sciences and brain imaging. On the Earth sciences front, our visualization efforts will be focused on volume visualization, in particular, 3-D reflectivity volumes that are now commonplace in both the oil industry and to a lesser extent in academia. Seismic images from the *ARAD* 3-D experiment will be used to demonstrate volume visualization on the *OptIPuter*. This test volume highlights the fine-scale structure of magma underlying the East Pacific spreading center located at 9°N. The dataset is 20 km by 20 km in map view, with the migrated data volume occupying 1000 by 1000 by 800 points, or roughly 3.2 gigabytes. Simultaneous visualization of multiple data volumes will also be shown to highlight differences in amplitude variation with offset (AVO) patterns that are related to the abundance of interlocking crystals within the magma. These co-registered data

volumes will be 6.4 gigabytes in size. Stereo visualization will also be supported in this configuration.

Additional efforts in networked visualization include our development of technology to share 3+ megapixel stereo-displays across metro distances and beyond. Through cooperation with SGI, Teraburst Networks, Panoram Technologies and Cox Communications, we were able to develop hardware/software that allows simultaneous viewing of theatre-sized, immersive environments in stereo. Our initial test was between Visualization Centers at Scripps and San Diego State University, some 44 miles apart, with Onyx 3400 systems at either end. A Panoram GVR-120 theatre-sized screen was attached to each SGI, displaying both mono and stereo signals from each site—this was a first (stereo). Recently, SGI and Teraburst have jointly marketed this solution for far-reaching, distributed visualization between visualization centers.

Results, Observations, and Conclusions

The level-0 *OptIPuter* is presently being constructed and rigorously tested at Scripps and EVL, and will be available for use starting in October, 2003.

Significance of Subject Matter

The *OptIPuter* represents a dramatic shift in visualization that will enable investigation of large data volumes. In 4 years time, the goal of this project is to render volumes that are 10s of gigabytes in size, and display them at resolutions exceeding 100 megapixels/screen.