VolumePro: At the Frontier of Advanced 3D Graphics

Hanspeter Pfister

Mitsubishi Electric Research, 201 Broadway, Cambridge, MA 02139, pfister@merl.com

Abstract

Imagine a doctor having the ability to visualize and diagnose a defect in an unborn baby's heart. Imagine a team of geophysicists being able to interact in real-time with seismic data in the discovery of a deep ocean reservoir of oil. Imagine a cell biologist visualizing in-vivo the precise molecular structure that allows a new AIDS drug to attack mutant strains of the virus. Imagine that every piece of luggage moving through airports is instantly inspected with high accuracy to ensure the safety of all traveling passengers. This is the promise of real-time volume rendering.

'VolumePro', Mitsubishi Electric's new family of PCI boards, provides the power to solve these and other difficult problems for the first time on PC class computers. 'VolumePro' achieves significantly higher levels of performance and image quality than has previously existed. It visualizes not only external but internal properties of acquired or simulated 3D data through real-time volume rendering.

Volume Rendering

The concept of volume rendering is not new. It has been explored as a research subject for nearly two decades. Volume rendering differs from conventional 3D graphics in that traditional graphics represents surfaces of objects using polygons or triangles, whereas volume data represents object interiors as well as their surfaces. Volume rendering displays visual images directly from volume data, enabling the viewer to fully reveal the internal structure of the 3D data.

Volume rendering has become a key technology for the understanding and evaluation of the vast amounts of scanned 3D data. 3D medical acquisition techniques, such as Magnetic Resonance Imaging (MRI) or Computed Tomography (CT), are being used daily in thousands of medical institutions. Confocal microscopes are being used by scientists to acquire the 3D internal structure of cells. Volume rendering is crucial in interpreting 3D geophysical data, giving insights into oil and gas distribution and helping pinpoint drilling sites. High-energy CT scans of airplane wings or turbine blades reveal material defects at the micro-millimeter scale. Modern explosive detection systems for luggage checked at airports are also based on CT technology.

But practically speaking, volume rendering has not been commonplace because the right combination of hardware, software, and tools to make real-time volume rendering feasible did not exist. Real-time, in computer graphics, means displaying new images at a speed which the human eye perceives as instantaneous, such as in a movie. The movie standard is 24 frames per second; 'VolumePro' provides an even higher display rate, 30 frames per second. Proprietary hardware systems, such as supercomputers, provided some ability to display volume objects in real-time, but at prohibitively expensive price points. Having the ability to visualize object interiors in real-time on pervasive PC computers allows many applications to finally take advantage of this important technology.

VolumePro

The 'VolumePro' PCI accelerator board is the first product of its kind in the market. 'VolumePro' features an ASIC rendering engine that is able to transform 1 billion bytes of volume data per second into 500 million shaded and colored samples per second. This is enough to render 256 slices of data with 256 x 256 pixels each at 30 frames per second. The high level of performance and image quality achieved by 'VolumePro' can not be achieved by any other conventional graphics card today at any price point.

The 'VolumePro' board comes configured with 128MB of usable volume memory. 'VolumePro' comes equipped with a rich set of hardware assisted features like cropping, slicing, line or plane cursor support, super-sampling, multiple light sources, and more, all calculated on-the-fly. The internal architecture employs a ray-casting algorithm, which shoots rays through a volume object from each pixel in the image. It linearly interpolates samples along each ray, provides complex shading calculations and color assignments at the sample points, which are then accumulated into the final pixel colors.

Summary

Real-time volume rendering is one of the new graphic frontiers of visualization and imaging. The 'VolumePro' board is a breakthrough enabling technology that will revolutionize the field of volume visualization by making real-time volume rendering widely available on common PCs for the first time. Jim Foley, CEO of Mitsubishi Electric's Information Technology Center America, says: "We believe that real-time volume rendering will make a huge difference in people's lives, from making us feel safer about air travel to offering us medical procedures that are faster, safer, and more accurate than ever before."

Acknowledgments

Special thanks to the Volume Graphics team at Mitsubishi Electric who made a dream come true. Thanks to Professor Issei Fujishiro who translated this article to Japanese.

For More Information

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Mitsubishi Electronics America, Inc
Real Time Visualization Group
1050 East Arques Avenue
Sunnyvale, CA 94086-4601
Marketing: 408-774-3299 or 408-774-3092
Sales:  617-621-7575
Main Number: 408-730-5900
Fax: 408-737-1125
Web: http://www.rtviz.com
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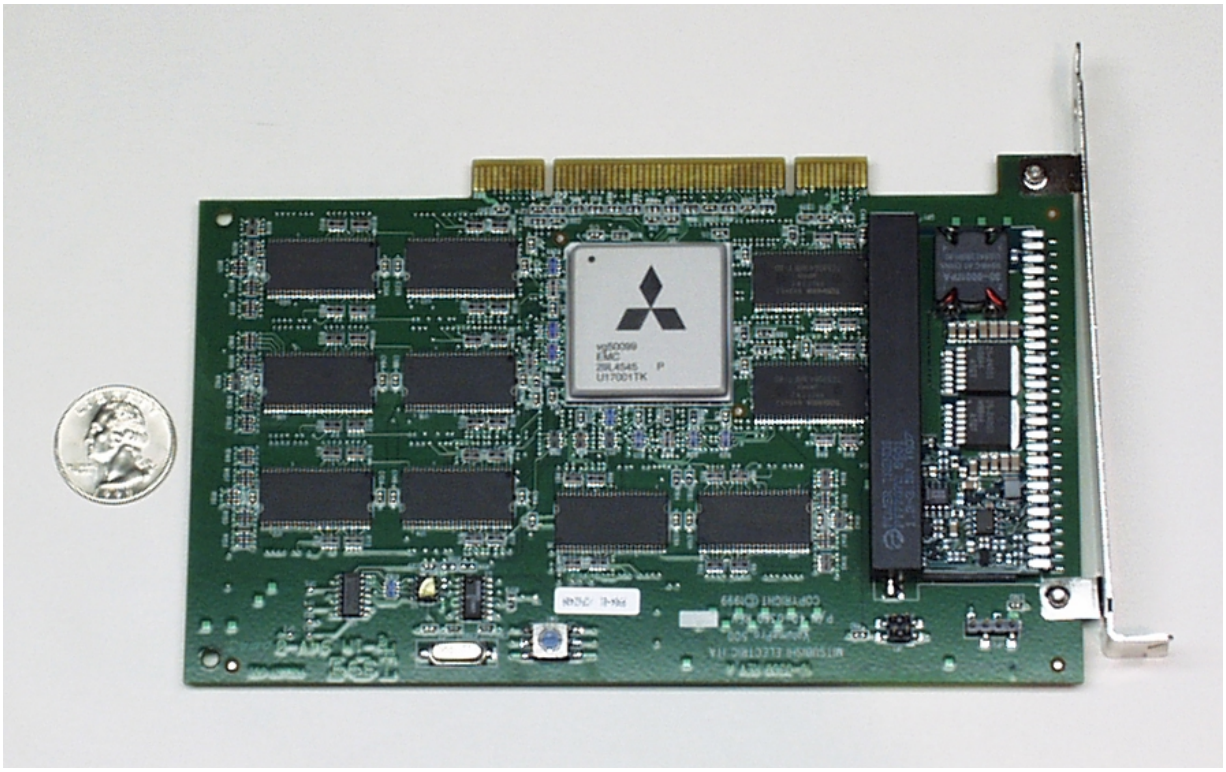

Figure 1: *The 'VolumePro' PCI board with the vg500 volume rendering chip and 128 MB of memory for volume data.*

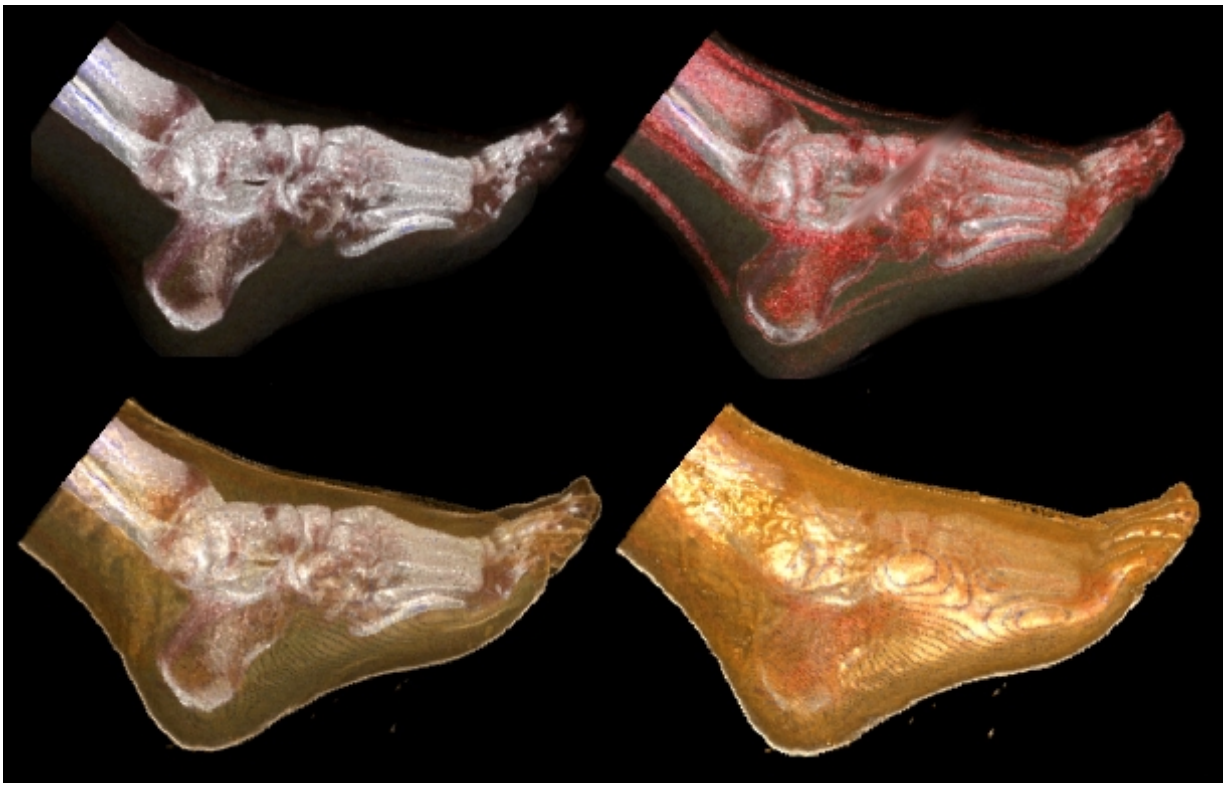

Figure 2: *A CT scan of a human foot rendered with different shading and color assignment in real-time on 'VolumePro'.*

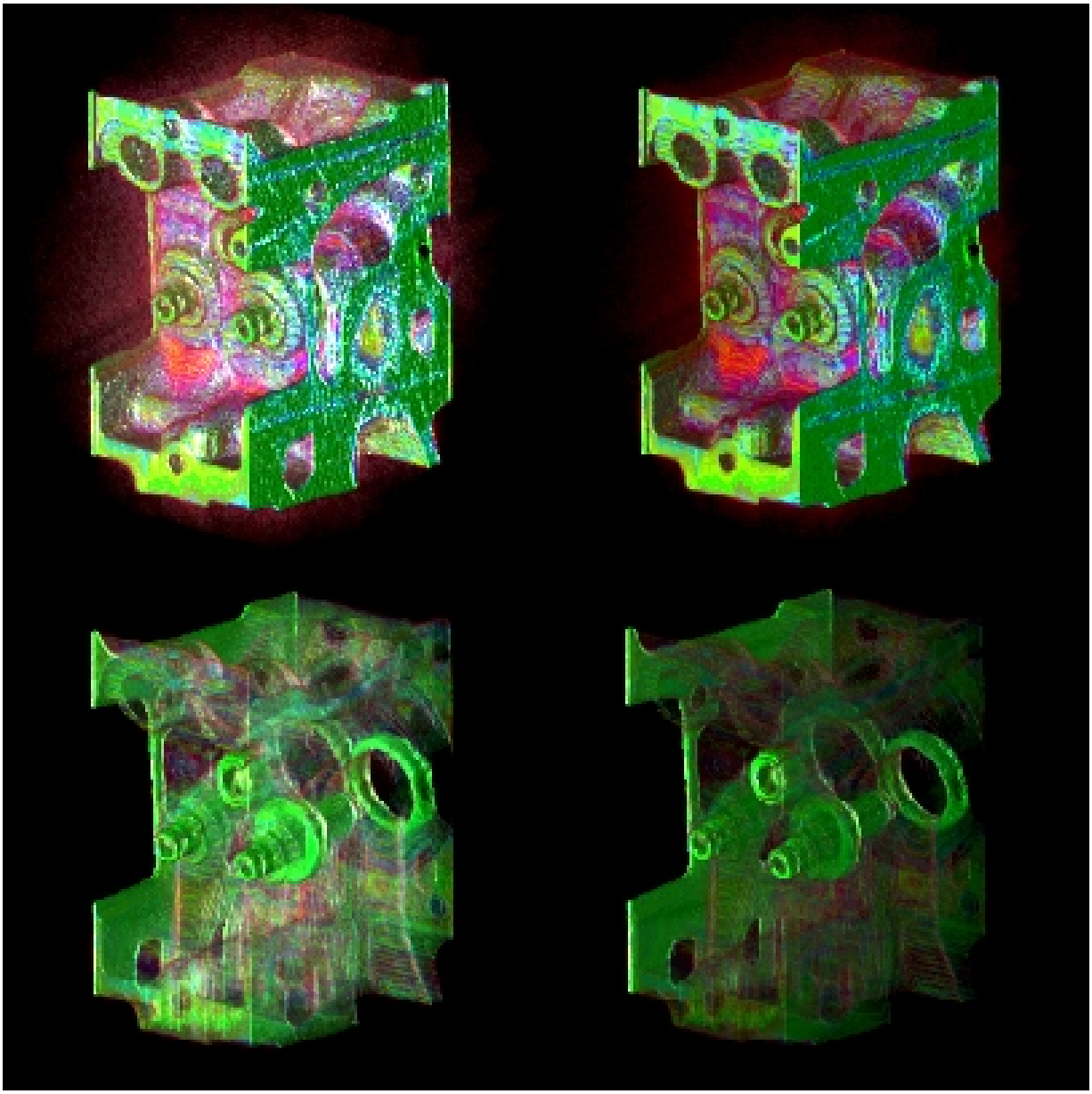

Figure 3: *A CT scan of an engine block rendered with varying translucency on 'VolumePro'.*

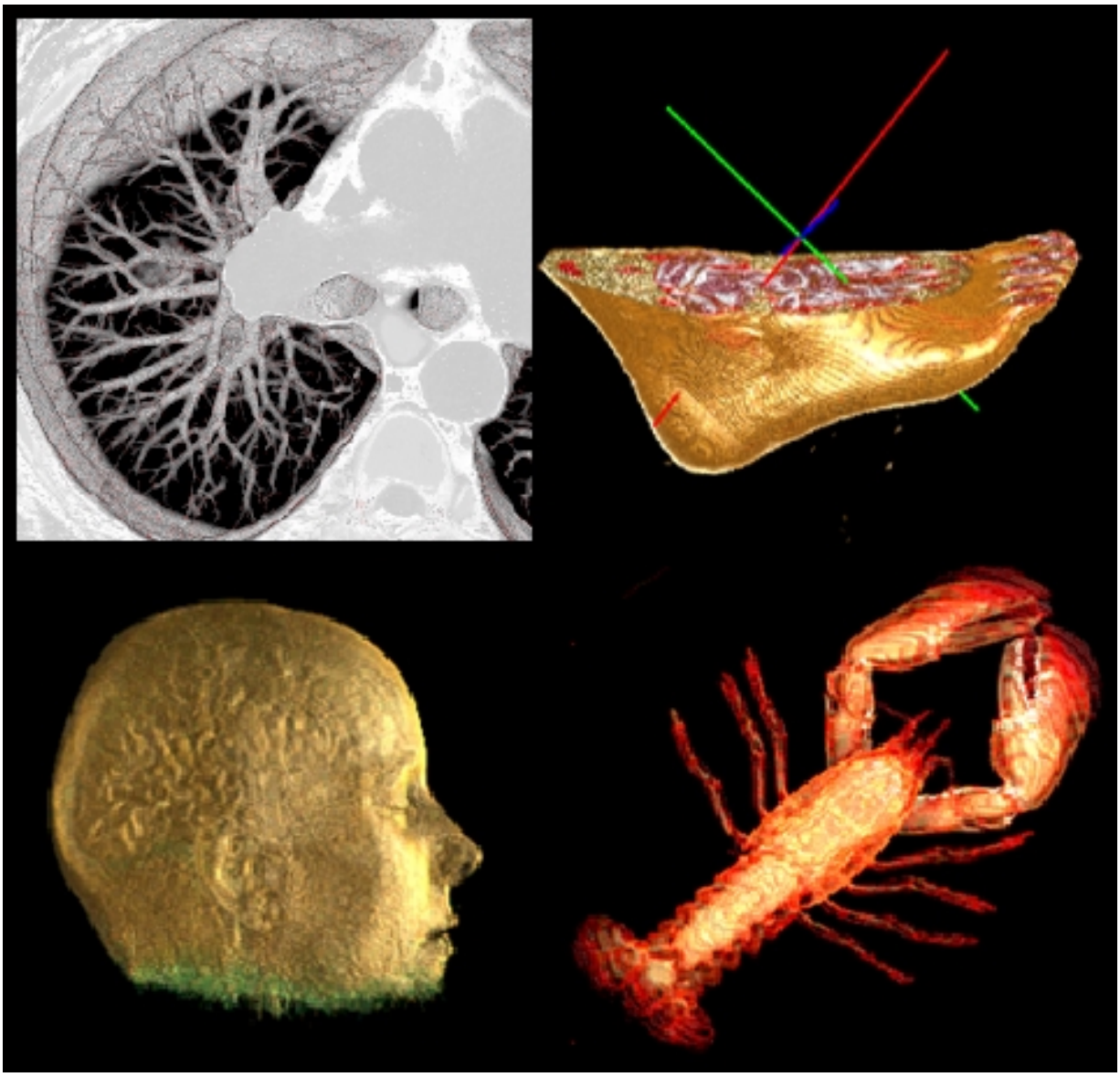

Figure 4: *Different volume datasets rendered at 30 frames per second on 'VolumePro'. Clockwise from the top: CT scan of a human lung, CT scan of a human foot, CT scan of a lobster, MRI scan of a human head.*